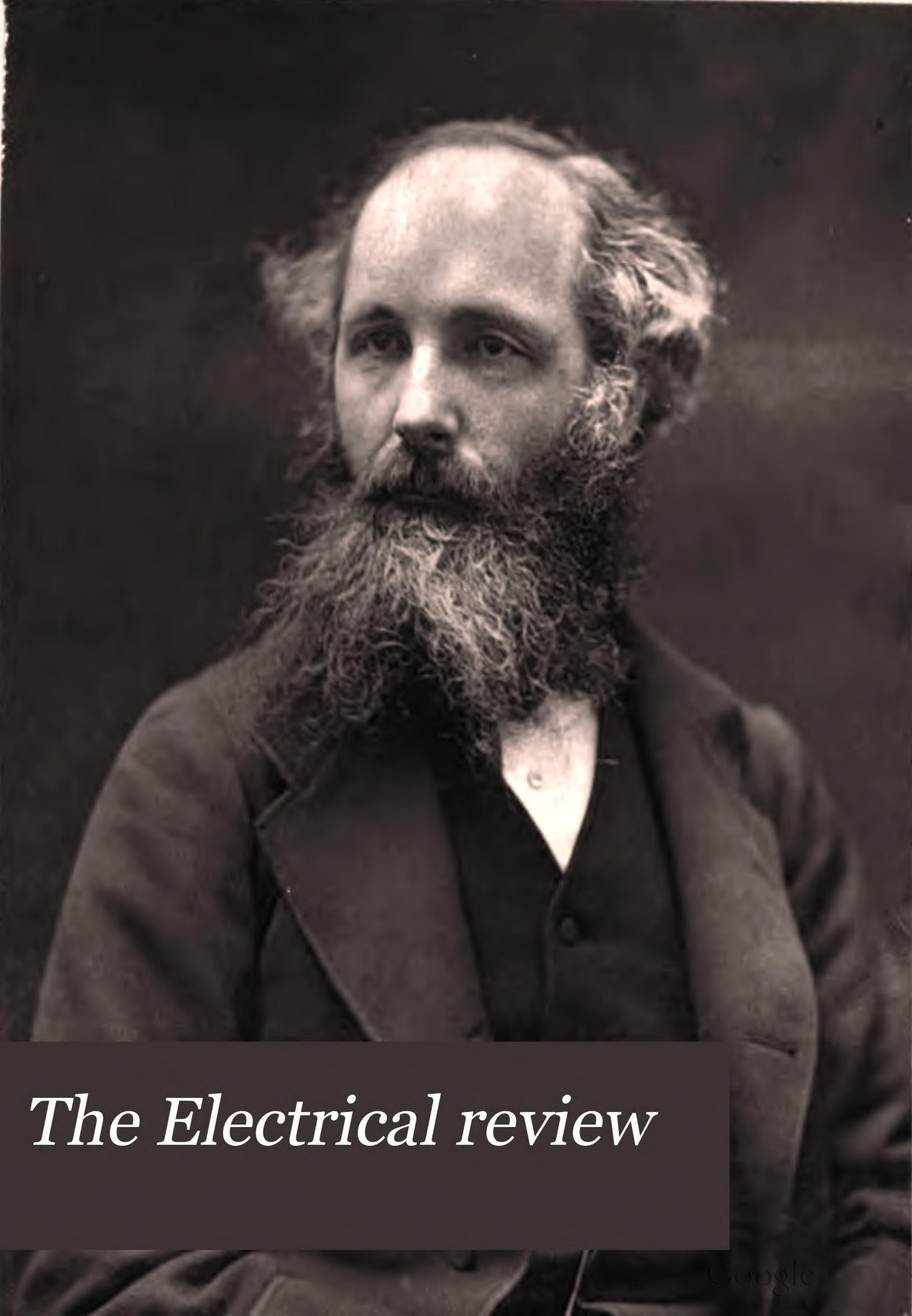

The Electrical review

THE

TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—1880.

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AND

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THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 166.

1879.

THE year 1879 has been, in many respects, a noticeable one, though new discoveries or inventions in the electrical and telegraphic world have not been abundant; but, at the same time, much quiet progress has been made in perfecting and extending the work done in previous years. The meeting of the Telegraphic Congress in London has, undoubtedly, been the event of the year, and for this reason alone 1879 will be marked out in the annals of telegraphy as being eventful, although, of course, the progress of invention and discovery is in no way affected by the fact of this gathering having taken place.

The results of the Congress have yet to be seen, and the resolutions arrived at have yet to take effect; but there can be no doubt but that much good will have been done, and, apart from the mere commercial questions involved, the gathering of so many representatives from every quarter of the globe, and the exchange of ideas and social courtesies amongst so many eminent men, will have been highly beneficial. In his inaugural address before the Society of Telegraph Engineers, Lieutenant-Colonel (then Major) Bateman-Champain pointed out the results that had arisen from the previous Congresses. The Society had the honour of entertaining the members of the Congress, and by this act of courtesy showed its desire to be considered, as much as possible, an International institution.

As the report of the secretary stated, the Society of Telegraph Engineers is in a very flourishing condition, its members numbering over 1,000 strong, whilst it possesses an electrical and telegraphic library unequalled in the world. The papers read and discussed by the Society have been of great interest, and mostly of a very practical nature; this alone indicates the progress which telegraphy and electricity continue to make.

Of all the inventions which have been brought forward during the past year, perhaps the Writing Telegraph, of Mr. Cowper, and the Induction Balance, of Professor Hughes, are deserving of the most notice. Both inventions, when more perfectly developed, are likely to prove of great value. The former was brought before the Society of Telegraph Engineers and excited great interest. The invention of Professor Hughes was described in a paper read before the Royal Society. By its means it was found possible to detect very minute traces of impurities in various metals; the instrument also seems likely to be of great value in determining the state of the auditory nerves of persons in good or bad health.

The progress of the electric light during the year, though considerable, can hardly be considered to have been rapid. Certainly the progress and the results predicted have by no means been realised. Gas has not been, and is not likely to be, superseded as a whole by the electric light. The outside public, whose scientific knowledge is at the best but very limited, take fright very easily, and every new invention or display in electric lighting is regarded by them as another nail in the coffin of the gas companies; the latter are, however, a very long way off from being extinct, though there is undoubtedly great room for improvement in the quality of the article they supply.

The inventions, and patents taken out to secure the same, in connection with the electric light are very numerous. Between July, 1878, and July, 1879, about 80 patents have been taken out which deal directly with the question of electric lighting, and almost every bi-weekly list of published patent specifications finds a further number added. The Patent Office and patent agents are certainly doing a flourishing business in this direction.

The exhibition of electric lighting apparatus held at the Albert Hall at the beginning of May, and which was heralded by a short inaugural address delivered by Mr. W. H. Preece, before H.R.H. the Prince of Wales, brought together a most interesting collection of inventions related to the subject.

The Parliamentary Select Committee, under the presidency of Sir Lyon Playfair, appointed to consider whether "it is desirable to authorise municipal corporations or other local authorities to adopt any scheme for lighting by electricity," gathered information on the subject of electric lighting from every available source, and the evidence of the most eminent experts was obtained; but the committee did not consider that the progress made by the electric light was sufficient for any definite steps being taken in the matter at present; since that time up to the expiry of the last year, although progress has been made, it has not been sufficient to justify the question of practicability being considered as definitely settled.

Very great differences of opinion continue to exist as to the relative cost of electricity *versus* gas, and this question has by no means been satis-

factorily answered as yet if everything be taken into consideration.

During the year several improved dynamo-machines and lamps have been brought prominently before the notice of the public; amongst the former we may mention the Brush, the Siemens-Alteneck, the Schuckert, and the Elphinstone and Vincent. Mr. Edison has also devised a dynamo-machine which is said to be of remarkable efficiency. On this subject a lively discussion has been carried on for some time, notably on the other side of the Atlantic, but no definite conclusion on the point as yet has been arrived at.

A large crop of electric lamps has sprung into existence, amongst which may be mentioned those of Messrs. André, Edison, Fuller, Heinrichs, Hickley, Higgins, Jamin, Krupp, Lontin, Mori-Griffin, Orme, Rapieff, Reynier, Sawyer-Man, Siemens, Wilde, &c. The candles of M. Jablochkoff and the lamps of other well-known makers have undergone considerable improvements, resulting in added efficiency.

The electric light has been applied to several large buildings, notably to the reading-room of the British Museum. The lighting of the Thames Embankment has also been considerably extended, and the circuits in connection with the same carried to the Victoria Station of the Metropolitan Railway. In several provincial towns the electric light has been applied for lighting factories, &c. Recently another sensational telegram has been received from America announcing the discovery by Mr. Edison, "quite by accident," of a new electric lamp, which is to do wonders.

The use of the telephone is quickly spreading, and already the principal English towns have "telephone exchanges" in full working order, and the movement is likely to extend rapidly.

The telephonic inventions and patents, like the electric lighting patents, are very numerous, and must have added considerably to the receipts of the Patent Office and patent agents, and we hope also to the pockets of the inventors.

The chemical telephone of Mr. Edison is undoubtedly one of the most remarkable inventions of the American genius, and promises great things. The Blake transmitter has also been found very efficient; whilst an invention of our own country, the microphonic transmitter of Mr. Crossley, is remarkable for its extreme simplicity and small liability to get out of order; it has been used with great success. Of the Gower telephone, which seemed one of the most promising forms yet invented, but little has been heard of late, although it was prominently brought before the Society of Telegraph Engineers in the course of the year. The Ader telephone is a foreign invention which has furnished some good results.

In general telegraphy, fair progress has been made. Though no remarkable inventions have been brought forward, the new duplex of Messrs. Theiler is, however, worthy of notice. The improved battery of Howell also seems likely to be of considerable value.

The military disasters at the Cape Colony have resulted in the establishment of telegraphic communication between that place and the rest of the civilised world, thus completing about the last important link of the vast network of cables now laid all over the globe. The laying of another Atlantic cable has rendered telegraph communication between the Old World and the New still more secure.

The problem of the transmission of power to a distance has received a considerable impulse during the year, but at present the subject is quite in its infancy, and the actual progress made has been but small. The experiments of M. Menier, however, in ploughing by electric power through the agency of a Gramme motor, have excited considerable interest.

Death has been active during the year, and we have to regret the loss of several most eminent electricians and scientific men. Amongst these we may mention Professor Clerk-Maxwell, Sir William Fothergill-Cooke, Mr. R. S. Brough, in our own country, and Professor Volpicelli abroad.

TELEPHONE EXCHANGES AND THE POSTAL TELEGRAPHS.

THE now rapid progress in England of the system of telephonic exchanges is bringing into notice the peculiar position in which the postal authorities are placed by the use of that beautiful electrical instrument, the speaking telephone. At the time most of the Telegraph Acts were framed there was no anticipation of the transmission of articulate sounds along a telegraph wire, and it becomes at the present time a nice question as to how far the Telegraph Acts can be applied to protect the Government monopoly from what it is thought, rightly or wrongly, might become, so far as the aforesaid monopoly is concerned, a serious interloper. It may be of interest to many of our readers if we recite a few of the passages in the Acts before mentioned which seem most nearly to touch on the subject. In 1869 was passed an "Act to alter and amend the Telegraph Act, 1868." The preamble contains the following:—

And whereas, in order to protect the public revenue, it is expedient that similar powers to those conferred upon the Postmaster General with respect to the exclusive privilege of conveying letters should be enacted with reference to the transmission of public telegraphic messages within the United Kingdom of Great Britain

and Ireland; and that the said Act should be amended in other respects.

This clearly makes it the duty of those in authority in the Telegraph Department to enforce the Act where necessary, for the protection of the revenue. In paragraph 3 it is stated:—

The term "telegraph" shall, in addition to the meaning assigned to it in "The Telegraph Act, 1863," mean and include any apparatus for transmitting messages or other communications by means of electric signals:

The term "telegram" shall mean any message or other communication transmitted or intended for transmission by a telegraph.

Here it will be perceived is mentioned the word "signals," and it is probable a contention will arise as to the meaning of the word. Is an articulate sound a signal? The passage as to the word "telegram" depends on the particular interpretation observed in the preceding paragraph.

By reading paragraphs 4 and 5:—

4. *The Postmaster General, by himself or by his deputies, and his and their respective servants and agents, shall, from and after the passing of this Act, have the exclusive privilege of transmitting telegrams within the United Kingdom of Great Britain and Ireland, except as hereinafter provided; and shall also within that kingdom have the exclusive privilege of performing all the incidental services of receiving, collecting, or delivering telegrams, except as hereinafter provided.*

5. *There shall be excepted from the said exclusive privileges of the Postmaster General all telegrams of the following descriptions: (that is to say),*

Telegrams in respect of the transmission of which no charge is made, transmitted by a telegraph maintained or used solely for private use, and relating to the business or private affairs of the owner thereof:

Telegrams transmitted by a telegraph maintained for the private use of a corporation, company, or person, and in respect of which, or of the collection, receipt, and transmission or delivery of which no money or valuable consideration shall be or promised to be made or given:

Telegrams transmitted, with the written licence or consent, either special or general, of the Postmaster General, under the hand of any officer of the Post Office, authorised for that purpose by the Postmaster General.

It will be noticed that over telephones for use by private firms, or a corporation or company, the Postmaster General has no authority whatever; here a question is, however, likely to arise. Is intercommunication by means of a telephone exchange an infringement of this law? Is an exchange a company? We have our own opinions on these points, but as they will probably ere long be placed for settlement before the Law Courts we refrain from expressing them at this juncture. It is, nevertheless, certain that telephonic means of communication is now fairly established, and must become in the near future an absolute necessity, and therefore the less interference the Postmaster may find necessary the better. The exchanges are for the convenience of the public, and even supposing the law should be found against them, still it seems to us the case could well be met by the Post Office licensing them by their paying a merely nominal amount. The principal use of the telephone should be over short distances, say a mile or a mile and a half, and over these distances few would telegraph by postal wires, therefore far from being an interloper, it should be considered but as an extension or ramification of the departmental main arteries. It is possible that the authorities at the General Post Office may in duty test the matter, whether they wish it or not, but apart from the expense and obstruction to business which the testing of such well balanced questions involve, the telephone companies have much to gain if they win, and we fancy little to dread if they lose.

ON A NEW FORM OF RESISTANCE BALANCE ADAPTED FOR COMPARING STANDARD COILS.*

By J. A. FLEMING, D. Sc. (University of London), Scholar of St. John's College, Cambridge.

1. The British Association Committee on Electrical Standards concluded their valuable labours on the Unit of Resistance by constructing copies of the selected standard. Certain of these coils, some fourteen in number, are at present preserved in the Cavendish Laboratory at Cambridge. It is important that these coils, which consist of wires of various alloys, should be from time to time carefully compared together in order to determine whether the ratio of their resistances at definite temperatures remains the same.†

Observations ought also at the same time to be made of the temperatures at which they agree, and also of their co-efficients of variations of resistance with the temperature. In using for the purpose the ordinary form of divided-metre bridge, several objections present themselves which render it a tedious process to determine accurately the difference in the resistance of two coils at different temperatures, and hence to deduce their variation co-efficients. It seemed on consideration that a modification of the usual form of Wheatstone's Bridge would render these processes more expeditious and at the same time more accurate. It is the object of the present paper to describe a form of Resistance Balance which has been recently constructed for the Cavendish Laboratory, and which experience shows to have several decided advantages over the old form.

2. *Description of the Resistance Balance.*—A circular disc of mahogany 18 inches in diameter and about 1 inch thick, *f* (see fig. 1), stands upon three short feet, L. Upon this and concentric with it is screwed down a disc of ebonite 14 inches in diameter and ¾ of an inch thick, *e*. The ebonite disc has a semicircular groove turned in its circumference. The circular wooden base extends on one side into a narrow rectangle, *j*, 4 inches wide, and of the same thickness as the disc. To this is connected two other rectangular pieces, *h i*, which are joined together by slotted brass bars, *y*, *y'* (see fig. 2), underneath, in such a manner as to permit the two intervals to be made wider or narrower at pleasure. This promontory is of wood of the same material

* Read before the Physical Society, December 13th, 1879.

† A detailed and most careful comparison of these coils was made by Professor G. Chrystal and Mr. S. A. Saunder in 1875, and their report is printed *in extenso* in the Report of the British Association at Glasgow in 1876. This is the most recent occasion on which the coils have been examined.

and thickness as the disc *f*, and is supported and levelled by three levelling screws, *n*, *n'*, *n''*. Through the centre of the ebonite disc passes a brass centre pin, D D' (fig. 2), on which is centred a brass arm, H H', capable of revolving round just free of the disc. Beneath the arm and soldered to it is a short brass spring, *x*, which depends vertically downwards. This spring carries at its extremity a small prism of platinum-iridium, with one edge vertical and turned inwards.

In the groove turned in the disc *e* is stretched a platinum-iridium wire about $\frac{3}{32}$ of an inch in diameter. The wire extends round about $\frac{25}{27}$ of the circumference, and is about 39 inches long, and the groove is of such a size that the wire lies with exactly half its thickness embedded in it. The ends of this wire are soldered to copper strips, *k k*. This wire is represented by the thick black line, A, C, A', in figures 1 and 2. On the wood rectangles, *j*, *h*, *i*, is fastened an arrangement of longitudinal copper strips, *k k*, which connect together eight transverse square copper bars in the manner shown in fig. 1. On the ends of these transverse bars are fixed vertical copper pins $\frac{5}{16}$ of an inch in diameter and $\frac{3}{4}$ of an inch high. On these pins are slipped short lengths of india-rubber tube, which extend beyond the pins, so that they form small cups about 1 inch deep, *s* (see fig. 2). The top of the copper pin is well amalgamated with mercury, and forms the bottom of the cup. These cups are filled about a quarter full of mercury. On the longitudinal strips of copper are fixed three binding screws, B, B', G, and a fourth, G', simply goes through the wood, and is connected by a wire underneath the base board with the centre pin D, and is therefore in metallic connection with the spring *x*. The battery is connected with the terminals B B', and the galvanometer with the terminals G G'. To the arm, H H', is adapted a trigger, T, of such shape that when the button *w*, which is of ebonite, is pressed down the spring *x* carrying the platinum-iridium knife edge is bent inwards until it touches the wire strained round the circumference of *e*.

The arm carries a vernier, *z*, which travels round, sunk in a shallow groove in the face of the ebonite disc, and the ebonite is graduated on the face on the margin of the groove. The graduations are cut into the ebonite and then rubbed over with powdered chalk mixed with gum and water. This gives a graduation very legible and pleasant to look at.

The length of the wire is just 1,000 divisions, and the vernier enables these to be divided into tenths. The zero of graduation is so placed that when the pointer of the vernier reads zero, the knife edge on the spring *x* is exactly opposite the extremity of the platinum-iridium wire.

It is thus clear that the revolving arm carrying its knife edge can be moved round so that on pressing the trigger button *w*, the knife edge makes contact at any point of this wire, and thus connects this point with the terminal G'.

This part of the arrangement answers to the sliding block and piston contact-piece of the ordinary divided-metre bridge.

3. *Method of using the Balance.*—Let now two resistance coils of about equal resistance be provided, and let the coil terminals of one coil be placed in the mercury cups *p* and *r*, and those of the other be placed in *q'* and *s'*. And let two more coils be taken of not very unequal resistance which it is desired to compare with each other; let the terminals of one be placed in the mercury cups *a* and *c*, and those of the other in *b'* and *d'*. It will then be seen that if a battery be connected with B B', and a galvanometer with G G', that we have the usual Wheatstone's Bridge arrangement (see fig. 4, which gives a diagram of the connections).

Two quart Leclanché cells are best suited for ordinary use. If a more powerful battery is used there is danger of heating the platinum-iridium wire, and so expanding it that it may slip down out of its groove.

The coils in the intervals between the cups *p* and *r* and *q'* and *s'* form two branches, and the coil in the interval between *a* and *c*, together with the resistance of the platinum-iridium wire round to the place where the spring *x* touches it, forms the third branch, whilst the coil in the interval *b' d'*, together with the remainder of the wire, forms the fourth. The "Bridge" wire consists of the arm H H' and the wire under the base board together with the galvanometer inserted between G and G'. By moving round the arm H H', and pressing the button *w*, we can find a position where there is no current through the galvanometer. The copper strips, *k k*, are made of copper so thick that their resistance is practically nothing. Having established a balance between the conductors and read the vernier, the next operation is to lift up the legs of the coil which were inserted in the cups *a* and *c* and drop them into the cups *b* and *d*. Likewise a similar change is effected on the other side, the terminals of the coil inserted in *b'* and *d'* are changed to *a'* and *c'*.

An examination of the connections as shown in fig. 1 will show that the result of this operation is as if the coils had *changed places*, whilst preserving their former connection. Now let the arm be moved round and a fresh position of equilibrium found by pressing the trigger and reading the vernier. A little consideration will show that the difference of these readings gives the differences between the resistances of the coils in terms of a length of the bridge wire. For the amount by which one coil exceeds the other in resistance, is equal to the resistance of that part of the bridge wire included between the two readings.*

In order to render this method of determining the difference of two coils practicable, the platinum-iridium wire must be exceedingly uniform in resistance, or else a table of calibration will have to be made. Great pains was taken to procure a length of wire as uniform in size and resistance as possible, and considerable care was taken in laying the wire in its groove not to strain it in any way. It lies evenly in its groove, just sufficient tension being put upon it to keep it in its place. The whole resistance of the wire from end to end is not far from $\frac{1}{30}$ of an ohm at about 15° C.

* This method of obtaining the difference of two resistances in terms of a length of the calibrated bridge wire, was suggested by Prof. G. C. Foster, F.R.S., in a paper read before the Society of Telegraph Engineers, May 8th, 1872. In this paper is given an account of the method of calibrating a wire. It is obvious, without any further proof, that if the coil placed in *a* and *c* exceeds in resistance that placed in *b* and *d*, then on exchanging them, since the united resistance of coil and bridge wire remains the same, that the contact-knife edge must be moved back along the bridge wire by a length exactly equal in resistance to the excess of one coil over the other.

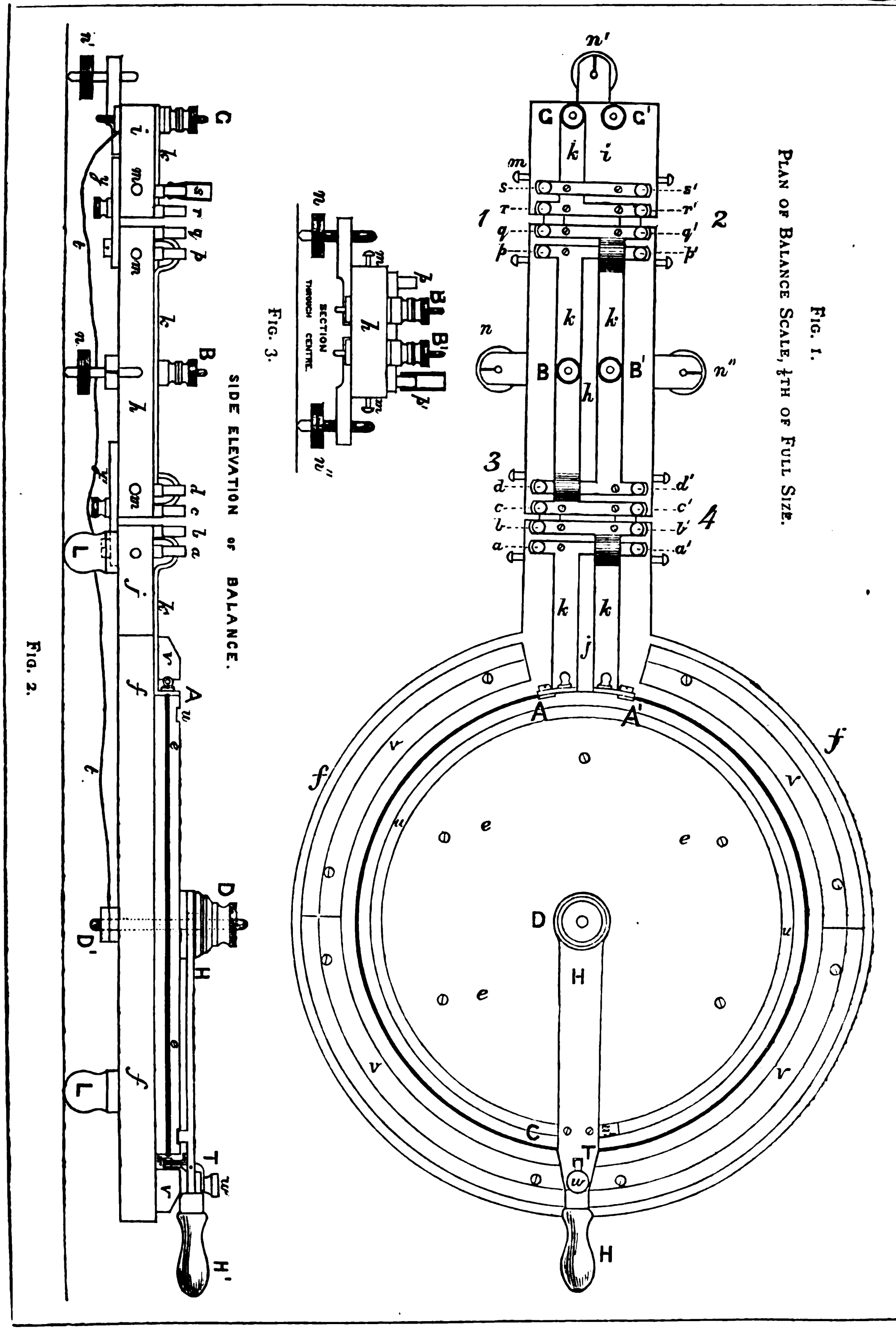


FIG. 1.
PLAN OF BALANCE SCALE, ¼TH OF FULL SIZE.

FIG. 2.
SIDE ELEVATION OF BALANCE.

FIG. 3.
SECTION THROUGH CENTRE.

The wire was carefully calibrated by measuring the difference in the resistance of two pieces of thick brass wire of such lengths that the difference of their resistances was about equal to that of thirty divisions of the bridge wire; and the difference was measured at about one hundred different positions all along the bridge wire, and found to be so nearly the same that no table of calibration was deemed requisite.

To protect the bridge wire from injuries, as well as to preserve it from being heated by radiation from surrounding bodies, a wooden ring, *v v*, is fastened down on the base board. The ring is 1¼ inch wide and ¾ of an inch deep, and its internal diameter is 1 inch greater than that of the ebonite disc. The wire therefore lies hidden away on the side of a square sectioned circular tube, and, furthermore, a shield of cardboard, faced with tin-foil, lies upon the face of the disc *e*, extending just beyond the ring. An aperture is cut in this shield to permit of the passage of the trigger, as well as to allow the vernier to be read. By this means the wire is not only out of sight, but out of reach of all radiation as well as mechanical injury.

4. *Method of determining the variation co-efficients of coils.*—To determine the variation co-efficient of any given coil, we proceed as follows: Three other coils are provided, two of them nearly equal in resistance, which we will call 1 and 2; a third coil, 3, must be taken, whose resistance is nearly equal to that of 4, the coil whose variation co-efficient is desired (see fig. 3).

The terminals of 3 are inserted in the mercury cups *a* and *c*, those of 4 in *b*′ and *d*′, those of 1 in *p* and *r*, and those of 2 in *q*′ and *s*′. Now the operation to be conducted is to keep the coils 1, 2, and 3 at a fixed temperature, and to keep four successively at two known temperatures, differing by about 15° C., and to obtain the difference of the resistances of 3 and 4 at these two temperatures. The difference of these differences, divided by the difference of the temperatures, is the mean co-efficient of variation of resistance between these temperatures. The chief difficulty to be contended with is that of keeping the temperatures of the coils constant during the operation, and of ascertaining what that temperature is. For, as Prof. Chrystal has remarked in his report (British Association Report, 1876), it is not easy to tell whether the temperature of the water in which the coil rests is identically the same as that of the wire, since the latter is embedded in a mass of slowly conducting paraffin. To reduce as far as possible the difficulty of keeping the coils at a constant temperature they are placed in water vessels made of zinc. These water boxes are composed of two cylindrical vessels, an outer case 9 inches high and 8 inches in diameter, and an inner one of lesser size. The two are connected at the top, so that they form a sort of jar, with hollow sides and double bottom. This interspace forms an air jacket. Around the inside vessel, near the top, is a row of small holes, and two tubes communicate at the bottom, one with the inner vessel and the other with the annular interspace. The top is closed by a wooden lid, with apertures for thermometer and stirrer. Water can be made to flow from the supply pipes into the inner vessel; it rises up and overflows through the holes and drains away down the interspace and out by the other pipe. The bodies of the four coils are placed in four water boxes of this description, and water from the town mains being sent in a continuous stream through all four water boxes, the coils are rapidly brought to and maintained at a known temperature. Any desired temperature can be given to one coil by leading warm water from a cistern into its vessel.

The annular air-filled space renders the rate of cooling very slow. Hence the coils, once at the desired temperature, can easily be kept there.

The advantage of the somewhat complicated arrangement of copper bars will now be seen. We can, without withdrawing the coils 3 and 4 from their water boxes, and without in any way disturbing the other arrangements, *reverse* the position of the coils 3 and 4 on the bridge, by simply lifting up the legs half an inch, and changing the mercury cups into which they dip. Thus the legs of coil 3 are changed from cups *a* and *c* to *b* and *d*, and those of coil 4, from *b*′ and *d*′ to *a*′ and *c*′. This exchange does not occupy more than a few seconds, and hence we can obtain the two readings necessary to give the difference of the resistance of the coils 3 and 4 when they are at different temperatures in a very short time. During this short time the temperatures of the two coils will not change perceptibly, protected as they are by an air jacket. In the ordinary form of straight bridge there is considerable trouble in exchanging the coils, because the water vessels have to be moved and the mercury cups re-adjusted, and all this time the coils are cooling, so that the two readings are never made under the same circumstances as regards temperature. Beginning, then, with all four coils at the same temperature, we take the difference between 3 and 4. To get them all at the same temperature, water from the town mains is allowed to circulate through the system for half an hour. At the end of this time the difference of 3 and 4 is taken, and several readings are taken at small intervals of time, to see if the temperatures are constant. This being done, the temperature of coil 4 is raised by the introduction of warm water, until it is about 15° above that of coil 3. It is best to raise the temperature about 20° above the other at first, and keep it there for twenty minutes, and then let it fall very slowly. In this way coil and water cool together, and an equilibrium of temperature is established between them. The difference between 3 and 4 is again taken, and from these two readings we have, as seen above, the mean variation co-efficient between the two temperatures. Professor Chrystal, in his report, threw out the suggestion that resistance coils should have a thermo-electric couple attached to them—one junction being buried in the heart of the paraffin surrounding the wire, and the other outside. This has been tried in some coils recently made, and proves a satisfactory method of ascertaining the equilibrium of temperature between the wire and the water.

Another source of error in the ordinary methods arises from uncertain or variable resistances at the mercury cups. It is important that the copper legs of the coil terminals should press very firmly against the tops of the copper pins on which the india-rubber tube cups are fixed. To ensure this, the plan adopted is to fasten on the coil legs an ebonite clamp; along the edge of the wooden promontory,

j, h, i (fig. 1) are put brass pins, *m*, and by means of steel spiral springs fixed to these, and attached to the clamps, the coil legs are pressed down very firmly. The ends of the pins which carry the india-rubber cups, and the ends of the coil-legs being well amalgamated, we get, when they are thus firmly pressed in contact, a very good joint, and one whose resistance is small and constant.

If the clamps are not used, then one leg may get lifted up a little, and thus a short length of mercury interposed, which leads to an error in reading.

5. *Example of a determination of the variation co-efficient of a coil.*—The whole resistance of the platinum-iridium wire is very nearly 0·0512 of an ohm, or not far from $\frac{1}{20}$ of an ohm, at about 15° C. As the whole length can be divided by the vernier into 10,000 parts, this gives as the value of one-tenth of a division, $\frac{1}{1000000}$ of an ohm.

The unit in the following example is $\frac{1}{10}$ of a division:—

Two coils were compared—call them F and K. K is the coil whose variation co-efficient is required.

I. Difference of resistances of F and K, at 11° C.

BRIDGE READING.

Experiment 1	5,000	4,955	45
Do. 2......	5,000	4,954	46
Do. 3......	5,000	4,955	45

The first column gives the number of experiment; the second, the reading, with the coils F and K in one position; the third, when F and K are reversed on the balance; and the fourth gives the difference of their resistances at 11° C., in units, of the bridge wire.

II Difference of resistance of F and K at 28·2° C.

Experiment 1	5,439	4,492	947
Do. 2......	5,442	4,497	945
Do. 3	5,440	4,490	950

As before, the fourth column gives the difference of F and K at 28·2°. Taking the mean difference at 28·2° to be 947, and that at 11° to be 45 units, we have

$$\frac{947 - 45}{28{\cdot}2 - 11} = 52{\cdot}4 \text{ units}$$

as the mean variation co-efficient between 11° and 28°. Since F and K are approximately ohm coils, this gives us as the variation co-efficient of the coil K, ·0262 per cent. This coil is of platinum-silver wire. These three determinations occupied about an hour and a half, during which time many more readings were taken closely agreeing with the above. In conclusion, I may state that this Resistance Balance has been constructed in the workshops of the School of Mechanical Engineering at Cambridge, under the direction of Prof. Stuart. Great care was taken in laying on the wire so as to avoid straining it in any way, and the performance of the instrument is consequently very satisfactory. I should also express the fact that this excellent performance is due to the supervising care of Prof. Stuart, who not only supplied several of the details of the construction, but aided by his valuable suggestions generally during the process of carrying out my rough designs into a practical form.

Cavendish Laboratory, Cambridge,
December, 1879.

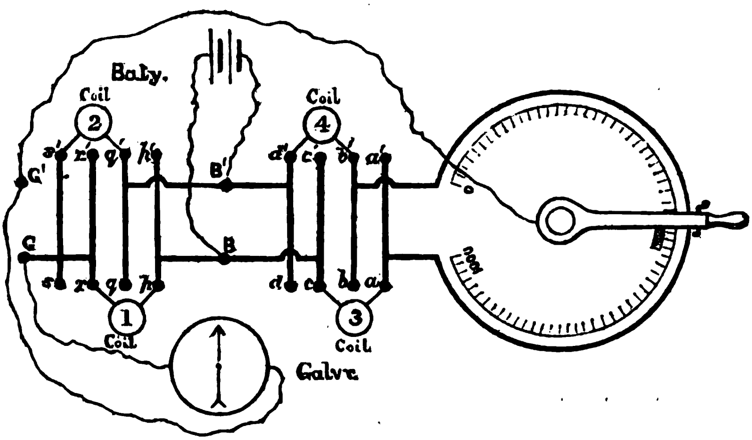


FIG. 4. DIAGRAM OF CONNECTIONS OF THE RESISTANCE BALANCE.

NEW RESEARCHES ON THE THEORY OF THE MICROPHONE.

By DR. JULIAN OCHOROWICZ.

III.

WE have seen from the last article that for the transmission of articulate sounds, the number of points of contact, the variation of this number during the action of the instrument and the variations of resistance resulting therefrom should be as great as possible.

It is with a view to these conditions that the principal form of Hughes' microphone, Edison's

carbon telephone, MM. Pollard and Garnier's telephone transmitter with double graphite crayons, M. Hellesen's transmitter, &c., are arranged. The form here illustrated is typical of all the others, and I find it very useful in all microphonic experiments. It can be employed for transmitting speech, singing of different degrees of loudness, the sound of a watch placed near it, of a fly placed inside, the music of a piano, &c. The membrane is of caoutchouc, tightly strained, and provided with a thin strip of tin-foil, to unite the lower carbon with the binding screw. It is easy to see that during the vibration of the membrane a greater or less number of points of contact connect the two microphonic electrodes, thus producing variations of resistance. The introduction of the microphone into the circuit considerably increases the resistance and reduces the strength of the current by one-fifth or more of its original intensity. The mechanical vibrations of the membrane may partly restore it, or still further diminish it; and although these variations are very small, they give, by virtue of their rapidity, a number of inflections which permit the reproduction of every shade of the voice.

If I mistake not, the influence of the energy of sonorous waves upon the intensity of sounds received by the telephone has not yet been fully recognised. On the contrary, one might almost be led to believe that it had no existence (*vide* Clerk-Maxwell, *Nature*, vol. 18, p. 162),* nevertheless, I cannot doubt it. Only it is necessary to take into consideration not the sonorous but the mechanical part of the phenomena. When one speaks in a low voice near the microphone, or in a high voice at a distance of some metres from it, the sounds are more feeble than when spoken in a high voice or near it. A loud-ticking watch is heard better than a quiet one, &c. The limits of proportionality are very narrow, it is true, but the differences of resistance are also. Increasing the latter we increase the former.

The supposed independence of the sounds in the receiver of those actuating the transmitter is based on a fact parallel to the first, namely, that the limits of *distinct* articulation are much narrower than those of non-articulate sounds. *The definition* and clearness *of articulate sounds transmitted by the microphone are in inverse ratio of their intensity.* The intensity increases in proportion as the microphonic vibrations tend to completely interrupt the current, while at the same time the faculty of transmitting articulate sounds disappears.

And this is the chief difficulty in the way of amplifying sounds at will.

The intensity of the sounds attains its maximum when the interruptions of current become complete; but then they can no longer be articulate: this is why we hear better when the speaking is in the ordinary tone than when it is in a high tone.

The intensity is also in direct relation to the strength of the current, but this relation is still more limited than the above. The microphonic indications commence as soon as the current has sufficient strength to overcome the resistance of the microphone and to flow through it. It is the sounds of complete interruptions which first appear; they are very feeble, and their modulation is as yet impossible. If the intensity of the current be augmented, modulation attains its first degree, and the sound of a watch is clearly perceived. It becomes stronger as the intensity of the current takes a third step, and then speech becomes perceptible. Just as the current increases so the intensity of the sounds increases, but their articulation dies out. Proportionality obtains only with simple sounds which produce the complete interruption of the current, and until the noise of sparking blots them out.

I have made a further series of experiments which show that the phenomena of the microphone depend very much upon the rapidity of movement of its constituent parts. This may be verified not only with feeble currents, but also with powerful ones. It is still more observable in liquid microphones and microphonic batteries, and may be proved by the following curious experiment:—Attach to the ends of a telephonic wire two pieces of iron wire, and immerse in a glass of water: microphonic action is observed as soon as the two ends are touched, or when one end is drawn out or put in, the other remaining in the water.

The sounds from the interruptions of the current are naturally very weak, but they become weaker still when the movements of the electrode are slow, and are entirely extinguished when the movement becomes slower still. On the contrary they become a little stronger when the movements are quicker and of greater amplitude. So in a bichromate battery, where the plates can be immersed at will, either singly or together, rapid immersion produces sharp sounds, while a slow and gradual immersion produces no microphonic action, even when carried deeper, although the intensity of the current increases, and the galvanometer needle is more and more deflected.

Variations of resistance and of current-strength are, therefore, not of themselves sufficient to produce microphonic phenomena: it is necessary that they be *rapid*.

The microphone itself alters the timbre of the voice, and this in a variety of ways depending upon the position of its parts and their initial pressure. By touching with the finger the movable bar, we can change the timbre in several degrees, and even produce spontaneous sounds corresponding to a rumbling, breathing, or plaintive crying, and that without any external cause intervening. This curious phenomenon is due to imperceptible skipping and slipping of the movable part of the microphone under the influence of its own weight. This can be produced artificially by making the microphone so that this automatic slipping is facilitated, and by placing the movable piece so that it can fall automatically. These noises are often sufficiently loud to be heard throughout a room, which proves that they result from interruptions more or less complete.

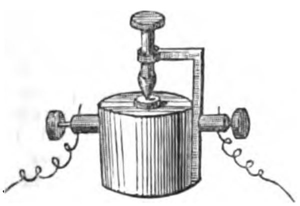
Simple sounds which result from a series of complete interruptions have always the same intensity and the same timbre, independently of the energy which produces them, but they vary in loudness according to the strength of the current.

The electric current being modified by the microphone throughout its length, and being competent to act at a distance by induction, it is not

* M. Wroblewski, professor in the University of Strasburg, even makes a law of this negation. "The energy of the sonorous waves has no relation to the intensity of the received sounds" (*Cosmos*, 1878, x. 398).

necessary to introduce the telephone into the circuit to hear the sounds. It is sufficient to bring it near to any point in the wire, microphone, or battery. For convenience it is better to use two telephones, and to bring one near while listening at the other. When, in place of the microphone, a coil with automatic make and break is introduced into the circuit, the transmitter telephone may be affected at a distance of a metre. If the telephone wires are joined directly to the secondary coil, the sounds, which may be heard throughout a room, are much louder than those of the interrupter itself. It is this sound which can be most easily heard in a microphone employed as a receiver.

This new and unexpected property of M. Hughes' marvellous instrument has been invoked as an insurmountable difficulty to the microphonic theory. "We cannot understand this at all," says M. du Moncel, citing the experiments of MM. Blyth and Hughes. Nevertheless, the fact is not so strange nor so new as was at first believed. The sounds



produced by the mere passage of an intermittent current have been profoundly studied by De la Rive in 1845* and by Beatson in 1846†. In the explanation it appears to me we must look to the various mechanical properties of the current. It is known that its passage influences the elasticity of its conductors (Vertheim), and although it cannot be strictly proved to lengthen the wire it traverses (Edlund), nevertheless experiments with the electric light (voltaic arc) show us that it effects a tearing away of carbon particles and carries them from one electrode to the other. We also know of the motion of liquid particles in the direction of a current, &c. It is therefore permissible to regard the electric current as a real *current* of water which carries with it in some fashion the material particles it encounters, especially when they are mobile. And if it is too weak to really carry them away, it nevertheless retains a tendency to do so which shows itself in almost imperceptible repulsions. And it is these repulsions which reproduce speech, being themselves produced by a current modulated by speech. We here find the same essential result as in the telephone—namely, a reciprocal transformation of cause into effect.

Sounds transmitted in this way are only perceptible when the solid conductor (a metal wire) is replaced by several separate and easily movable particles (the microphone); but it is easy to understand that they exist in a lesser degree at all points of the circuit. In proof of this it is only necessary to wind some insulated wire on a small wooden drum and to hold it against the ear. The loudness increases when a few pieces of iron are enclosed in the bobbin.

* *Comptes rendus*, xx. p. 1287. Pogg. Ann. lxv. 637.
† *Electro-Mag.* April, 1846.

Pushing the reduction of the telephone still farther, we can dispense with the receiving microphone and even the receiving coil by holding simple electrodes (metal plates or cylinders) against the temples. The intermittent current then passes by the head, and the dry skin here plays the same part as the sheets of paper in the singing condensers of MM. Varley and Pollard. An electric harp may also be constructed with fine wires close together, and this harp emits sounds when it is traversed by intermittent currents. In this case it is the air which plays the part of the bad conductor. Finally, a spiral of fine wire emits sounds under the influence of electro-dynamic attractions.

It only remains for us to say a word on the thermoscopic properties of the microphone. These come under the same explanation as served us to understand the action of the microphone when used as a transmitter; but, as we here have to deal with an electromotive action instead of a telephonic, the variations in the points of conductibility need no longer be *rapid*. Another and apparently contradictory distinction must be noticed. We know that Edison's microtasimeter shows effects altogether opposed to those of Hughes' thermoscopic microphone. In the former heat acts by an increase of conductivity; in the latter it is the reverse—heat increases the resistance. Why? Because in the first it is a *solid* body which dilates with heat and increases the *number of contacts*, while in the second, in which there are a number of small pieces of carbon juxtaposed, it is the *air*, which surrounds and separates them, which dilates most, and this dilatation necessarily produces a *diminution* of the number of contacts; the principle remains the same.

To recapitulate, it is impossible to discover in the microphone any new property of matter, or at any rate, in the direct action of sonorous waves on certainly low-conducting bodies. The microphone presents no analogy to the microscope, and it has nothing in common with selenium, though this does not make M. Hughes' invention any the less one of the greatest of our century.

The second theory, that of pressure, is but a superficial exposition of facts, and, in our idea, must be abandoned.—*La Lumière Electrique.*

LONG RANGE TELPHONING.—In a recent issue of this paper an exchange was credited with the statement that Mr. Robert Packer, "superintendent of the Pennsylvania Railroad," while travelling in Nebraska had conversed with his wife and friends at his home in Sayre, Pa., two thousand miles distant, by means of a telephone. We now learn on good authority that, though Mr. Packer's friends received his communication by telephone, it was not so sent by Mr. Packer. The message was sent from Nebraska to Mauch Chunk, Pa., by telegraph; thence it was telegraphed to the Sayre office of the Pennsylvania Canal and Railroad Company (of which Mr. Packer is superintendent), and from there it was transmitted to Mr. Packer's house by telephone—falling short of the newspaper report of the telephone's performance by some nineteen hundred and nine-nine miles and a fraction.—*Scientific American.*

GRAMME MACHINE FOR THE TRANSMISSION OF MOTIVE POWER.

THE importance of the important principle of the transmission of motive power to a distance is daily becoming more appreciated, and is making rapid strides towards taking the front rank in the engineering world. In our own country, at present, the subject is hardly likely to make very rapid progress, as the inland natural powers available for transmission are but very limited in number; when, however, the utilisation of the power of the tide, to which we have before referred, has been fairly taken in hand, then important results must certainly follow. In the meantime any advance made in the general question must excite great interest. The Gramme machine, of which we give illustrations, has been specially designed for the purpose of giving out the motive power transmitted to it in the shape of electricity, and four of which have been used with great success by M. Menier, on his farm at Noisiel, for driving a six-furrow Fowler plough, each machine developing 18 horse-power.

The arrangement of the whole machine is very solid, the frame being cast in one piece, and the armatures, which are four in number, are very firmly fixed to the frame and to the iron cases; the bobbins are large, and the collecting brushes, which are four in number, are securely held by binding, instead of being supplied laterally. The revolving bobbin is about 18 inches in diameter, and the same in depth.

The general details of the machine are self explanatory, and do not require description.

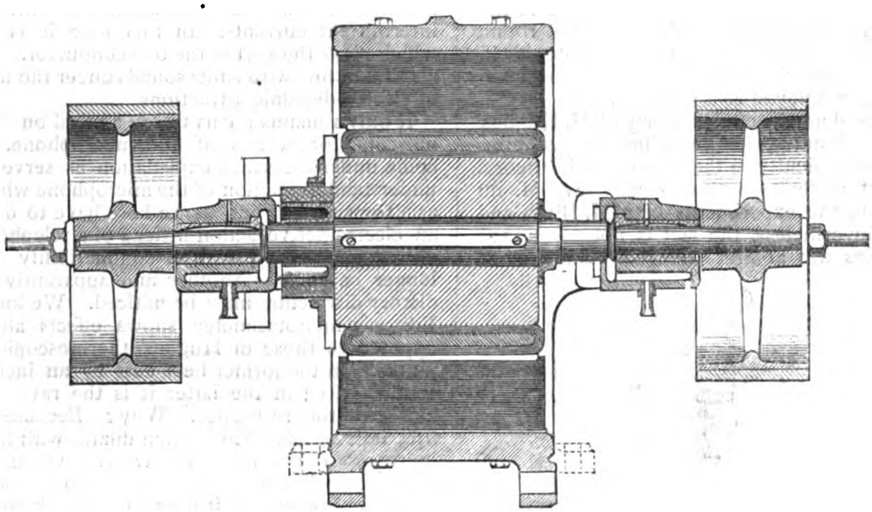


FIG. 1.—LONGITUDINAL SECTION.

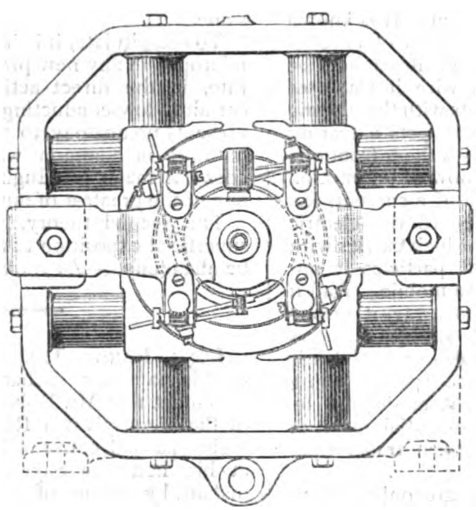


FIG. 2.—END ELEVATION.

LADD'S IMPROVED HOLTZ MACHINE.

THE ordinary form of Holtz machine, although a powerful generator of electricity when in good working order, is, nevertheless, uncertain in its action and somewhat cumbersome in form when of a large size. Mr. Ladd, of Beak Street, has greatly added to the value of the machine, without modifying its general construction, by constructing it with multiple plates, and enclosing the whole in an air-tight case, thus rendering it insensible to climatic changes, which so powerfully affect its good working. We have recently had an opportunity of inspecting one of these improved machines, and can testify to its extreme portability and efficiency. The glass case in which the whole is enclosed, air-tight, is but 2 feet 4 inches long, 14 inches broad, and 20 inches deep. It contains 6 fixed glass plates, 15 inches in diameter, and 6 revolving ebonite discs, 14 inches in diameter. The handle, which rotates the latter by multiplying pullies, passes out of the case through india rubber packing, and the conductors are brought out in a similar manner, so that no moisture can possibly enter the case to disturb the action of the machine.

The Holtz machine is very convenient for exhibiting most of the phenomena which usually require a large size induction coil to produce, whilst it is much more readily got into action as no batteries are required.

MACHINERY EMPLOYED IN THE LAYING OF THE NEW MARSEILLES-ALGIERS CABLE.

IN the paper lately read by Mr. March Webb, before the Society of Telegraph Engineers, on "Operations connected with the laying of the New Marseilles-Algiers Cable," full illustrated descriptions were given of the appliances used in connection with the work. Through the kindness of Mr. Webb we are able to give an illustrated description of one of the most important pieces of mechanism employed on board the *Dacia*, which was used in connection with the "paying-out" operations.

The machinery used in connection with the paying-out of a cable consists, first, of "the holding-back" gear, through which the cable passes immediately after it leaves the tanks; from this gear the cable next passes round the "paying-out drum," and thence through the dynamometer and over the stern sheave into the sea.

The "holding-back" gear is an important part of the machinery, as its function is first of all to steady the cable as it comes out of the tanks, and secondly to prevent its overrunning and fouling as it passes on to the paying-out drum. The ordinary form of "holding back" gear consists of four or five V sheaves, one in front of the other in a straight line; the cable lies and is pressed down in the V grooves of these sheaves by "jockey pulleys." Each of the V sheaves is provided with a brake. Such an arrangement practically gives but little holding-back power, and even if the brakes be applied so as to completely stop the turning of the V sheaves, the cable, when it has a heavy strain upon it, may become difficult to control, especially if it chances to slip on the paying-out drum, as is the case sometimes. The "holding-back" gear employed on board the *Dacia*, and which was used in the recent Marseilles-Algiers Cable Expedition, is the most efficient piece of machinery for the purpose yet devised, and it is extremely simple in its construction. Fig. 1 shows a plan of the arrangement.

A A A are iron segments firmly screwed on to a balk of timber. B B are iron segments which can be worked backwards or forwards by screws which are moved by bevilled wheels D D attached to the shaft E, the latter being provided with a hand-wheel F for turning the same.

The pressure and consequent friction which can be applied to the cable by increasing or diminishing the distance between the movable segments B B and fixed ones A A A can be regulated to any required degree by turning the wheel F; and thus any holding-back power required can be obtained; or by screwing the segments completely back the cable can pass perfectly freely. (*To be continued.*)

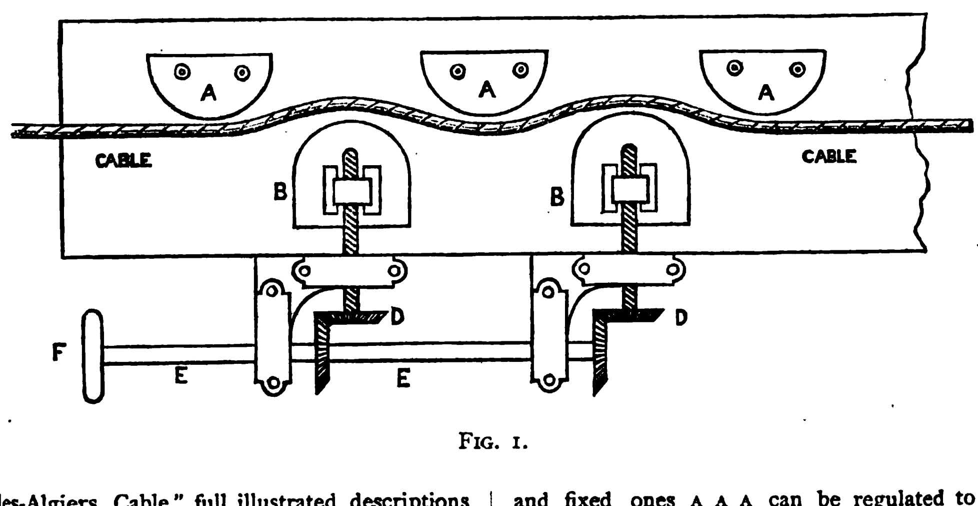


FIG. 1.

THE BRUSH SYSTEM OF ELECTRIC LIGHTING.

THIS system of electric lighting, an illustrated description of which was given in the number of the TELEGRAPHIC JOURNAL for Jan. 15, 1879, has lately been introduced into England by the Anglo-American Electric Light Co. (Limited), of Hatton-garden, London, E.C. An exhibition of this light took place at the company's premises on Tuesday, Dec. 23rd, in the presence of representatives of the press and others interested in the subject.

The introducers of this system claim that the drawbacks of expense, uncertainty, and complicated mechanism, which have hitherto stood in the way of an extended application of the electric light, are overcome, and economy, constancy, and simplicity secured. During the past year the system has been adopted very largely in the United States, and with most satisfactory results, in various institutions, hotels, colleges, shops, chemical manufactories, iron and steel works, worsted, linen, and cotton mills, dry goods stores, printing offices, parks, steamers, harbours, and mines, for all of which it has been found not only available, but advantageous and economical. At present the manufacturers there are unable to keep pace with the orders for the machines.

The system embodies important improvements and advantages in the three essentials necessary for electric lighting, viz.:—The generator or dynamo-electric machine; the lamps or carbon regulators; and the carbon.

The "Brush" DYNAMO MACHINES are made in several sizes, capable of operating from 1 to 16 or even more lights in *a single circuit*, which may be of 10 or 12 miles length if required. In construction, the machines differ essentially from all others, both in the armature, the arrangements of the field magnets, and the commutator; as will be seen by reference to the article in the Journal previously referred to, also the mode of connections adopted is novel, thereby producing, it is claimed, from a given amount of power, a larger available current than has hitherto been obtained from any other combination. At the same time, the mechanical construction is such that the wear and tear is reduced to a minimum, the wearing parts (the segments of the commutator and brushes) being easily replaced when necessary by an ordinary mechanic, at a trifling cost.

The current derived is continuous, and of such a nature as to enable it to overcome a great external resistance. In the "Brush" machine, known as No. 7, from 16 to 18 powerful lights can be operated in one long circuit, each with an arc of 2 millimetres in length, at a speed of 750 revolutions of the armature, absorbing about 13·5 horse-power, and consuming approximately one and a-half inch of carbon per hour per lamp.

The machines may be run for any number of hours continuously, and do not overheat or become less effective through continued use; further, by a special regulating attachment, any smaller number of lights than the maximum that may be required can be employed, absorbing proportionately less power.

The "Brush" LAMPS are very simple in construction, thus ensuring ease of management, safety against internal derangement, and regularity of working. Those exhibited on the 23rd were very similar to the one illustrated in the Journal; but ordinary double magnets were employed in the place of the single bobbin shown in the illustration. By means of the magnetic control and automatic "cut off," each lamp, though in continuous circuit with many others, is independent in its working. Thus a mean length of arc, and equality of light, and consumption of carbon is always maintained. The "cut off" effectually guards against all dangers of general extinction; should any one lamp in the circuit be thrown out by consumption of carbon or other cause, the remainder are not affected. In order to produce steadiness in the movement of the carbon the holder of the latter is connected to a small piston fitting loosely in a cylinder filled with glycerine, this damps the oscillations and prevents jerks.

The "factory, or general purpose lamp," consists of a strong rectangular iron frame, containing the regulator, the carbon holders, and support for the globe, and is placed in proper position, and at the same time in electrical connection with the other circuit lamps and generator, by simply *hanging* it up to its board, and thus doing away with all loose wires and screw terminals. These lamps are constructed to burn about eight hours without renewal of carbon. The "double rod" lamps are a modification of the above, and are especially useful when a light is required for a longer period than eight hours continuously. These lamps contain two sets of carbon holders and carbon rods, ingeniously constructed with a single regulator, which only allows one pair of carbons to burn at once, but instantaneously and automatically throws the second pair into circuit when the first are consumed. By means of these double rod lamps, a system of lights may be maintained in continuous operation for sixteen hours without requiring any attention; or, by introducing three rods and three sets of carbons, for twenty-four hours. It is obvious that the economical advantages of such an arrangement are very great in preventing waste or short lengths of carbon; for instance, in eight-hour lamps of other systems, when the lights are required, say, for periods of six hours consecutively, there is still carbon enough left for two hours, which is removed and wasted, whole new lengths being necessarily substituted for the next six hours' run—whereas with the new patent "Brush" lamps now introduced no removal of short lengths is necessary, thus effecting a saving of, say, 25 per cent. of carbons; for each pair would burn until consumed, when the next set is automatically and instantly substituted, not affecting the continuity of the light.

The other lamp is a focussing one, to use with reflectors for lighthouses and other suitable purposes, and a locomotive and ships' head light.

From a commercial standpoint, it is essential that the "CARBONS," which is the element of continuous consumption in electric lighting, should be as cheap as possible, for on this depends, to a great extent, the economic success of any system. At the same time, it is most important, in order to ensure a good light, that the carbon should be of great purity and uniformity. The "Brush" carbon is manufactured by a process which ensures these conditions. Recent analysis made in this country proves that it contains only a ½ per cent of foreign matter, as compared with from 2 to 3 per cent. contained in the very best samples of any other kinds that could be

produced. The uniformity is such, that in repeated observations, in a series of 16 lamps burning together at various times for many hours, no unequal consumption in any one of the lamps could be detected. The price at which it can be supplied is 4d. per foot.

From the peculiar construction of the Brush machines a large number of lights may be worked at a long distance from the dynamo-electric machine, with a very small loss of power. In an experiment made, the resistance in the circuit was suddenly changed from that equal to 1½ mile of conducting wire to a resistance equal to 250 feet only, and the effect on the 16 lights was barely appreciable. One pair of conductors only is required for all lamps, no matter what their number may be, and the loss due to these conductors falls, not on each lamp, but upon the whole circuit.

The experiments made on Dec. 23rd were very successful, the light being remarkable for its steadiness. Each of the lights, according to Mr. Ladd, had an intensity equal to 960 standard candles, the photometer being placed on a level with each lamp. With the lamp elevated so as to cause the rays to fall with an incidence of about 45°, the power is considerably greater, perhaps as much as 20,000 candles.

The engine employed to drive the dynamo machine was supplied and manufactured by Messrs. Wallis and Stevens, of Basingstoke, and worked with remarkable steadiness.

THE ELECTRIC LIGHT AT THE VICTORIA STATION OF THE METROPOLITAN RAILWAY.

ON Monday, Dec. 15, the first public trial was made of an electric lighting system for the illumination of the Victoria Station of the Metropolitan District Railway. This trial, which was a great success, was more particularly of interest in consequence of the distance of the illumination from the source of light. The arrangement is an extension of the system of illumination now in full action along the Thames Embankment and Waterloo Bridge, and which has been carried out, as is well known, by the Société Générale d'Electricité, of Paris, the engineer of which is M. J. A. Berly.

The actual distance between the Charing-cross Station, where the generating apparatus is located, and the Victoria Station, is 2,373 yards, and along this distance the leading wires are carried through the tunnel of the railway.

The illumination is carried out by means of Jablochkoff candles placed in opalescent globes.

The length of the station illuminated is 300 feet, its width 50 feet, and height 40 feet. There are two platforms, with a space of 20 feet between the two. Ten lights are employed, which are thus distributed :—

Five on the down platform, dividing the length in equal distances, four on the up platform, alternating with the five of the down line, and one central, situated over the middle of the bridge or passage connecting the up and down lines. Each light is about 13 feet above the ground, and all are suspended from the iron roof of the station. The lamps are of the same power and description as those used on the Thames Embankment, Waterloo Bridge, and elsewhere. They are enclosed in 16 inch opal globes. The same steam engine which is maintaining the 40 lights on the Thames Embankment and the 10 on Waterloo Bridge, is employed to produce the lights. The engine is, therefore, now maintaining 60 lights altogether.

The distance between the two stations of Charing-cross and Victoria, as we stated, is 2,373 yards, or 1·354 mile; but the length of wire between the two stations, owing to the curves and losses necessarily attending the laying, connecting, and fixing, amounts to about 1·65 mile; the whole circuit being, therefore, of a length equal to 3·30 miles.

The 10 lights are on two circuits, and maintained by the two spare circuits of the Gramme machine feeding the 10 lights on the Waterloo Bridge.

The leading wire is of the same description as that throughout the Thames Embankment, viz., a cable of seven strands of copper wire well insulated. The last electric lamp at Blackfriars Bridge is one mile from Charing-cross; the frontage thus actually covered is 2·65 miles.

A fourth 20-light Gramme machine has just been erected at the Charing-cross centre, and a trial of 80 lights, worked by a Ransomes, Sims, and Head's 20 nominal horse-power engine, will shortly take place.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I read in your Journal of the 1st December an account of a lecture delivered by Mr. W. Lant Carpenter on the daily practical applications of electricity in the United States.

In this lecture Mr. Carpenter is reported to state that having interviewed Mr. Edison at Menlo Park, and having seen his sub-division of the electric light, comes to the conclusion that he is no nearer to it now than he was some two years ago.

Unfortunately I had not the pleasure of knowing Mr. Edison so long ago, but upon a visit to the States about eight months ago I made the acquaintance of Mr. Datchelor, who was kind enough to post me up in the numberless inventions of Mr. Edison, including the sub-division of the electric light, to which I paid special attention.

Personally I was quite satisfied that Mr. Edison would ultimately succeed in his object, and it is only within the last month, upon my second visit, that I made Mr. Edison's acquaintance. I visited him twice in a fortnight, at the end of which I was more satisfied than ever that the result would be a grand success.

It is only within the last few days that the news reaches us of an attempt to light the houses in Menlo Park with these new electric lamps.

I should fancy every one will admit that this is a great move forward in this sub-division, and I hope will be sufficient to satisfy Mr. Carpenter that his statement is somewhat incorrect and misleading.

I am, yours, &c.,
CHARLES LEVER.

Bowdon, Cheshire.

[We cannot see that our correspondent in his letter has answered Dr. Carpenter's remarks on the subject; he, like Dr. Carpenter, has merely stated a conclusion

drawn from his own impressions, no *facts* are stated, except that an *attempt* (the italics are our own) has been made to light the houses at Menlo Park. This hardly amounts to a solution of the problem, we think, nor do we see how it can be characterised as a "great move forward in this sub-division."—ED. TEL. JOUR.]

TRIALS OF THE JABLOCHKOFF AND WERDEMANN ELECTRIC LIGHTS IN PARIS.

SIR,—In your issue of the 15th inst., under above head, you have shown, I think, rather too great bias in favour of the Werdemann light; but as you have ever evinced a desire to act fairly and impartially, I will put before you one or two points that suggest themselves.

M. Werdemann was to have lit the Mansion House and Exchange Place a year ago. Why has *nil* come of this? * * * * *

For the first time we learn that the system Werdemann was steady and silent, while its rival was noisy; also, that in the trial M. Werdemann used no globes to his lights, "thus to show the natural colour of the same." Surely this remark is unnecessary, as doubtless those superintending arranged details of the trial.

In the matter of the power required for each light, how unfair is the subject placed before the general reader. Twelve Werdemann lamps required, your article says, 6 horse-power or half horse-power for a light, while the Jablochkoff system took 12 horse-power for eight lamps, or 1½ to each light. No mention is made of the power of light, leaving it to be believed that the Jablochkoff required 1½ horse-power to each light. Whereas the fact is that one of them of quite 300 candles requires little over a ½ horse-power, while a Werdemann necessitates for a lamp of only 30 gas jets ½ a horse-power.

As the result of this experiment is in the hands of M. Garnier and M. Vaucorbeil, the Director of the Opera, it would, I think, have been better to have awaited their report before endeavouring to lead the public mind.

Whether the Werdemann system requires quantity currents as against intensity in the case of the Jablochkoff matters really very little; the former is a very pretty little light if well regulated; suitable, no doubt, for certain work: the latter can do anything; has proved its adaptability for interiors, shops, or warehouses, for street lighting, or for railway stations, near or distant from the seat of electric power, and by its last step, that, whether by intensity currents or not, it can light at nearly two miles from the engines, steam and electric, and without any regulator or apparatus of any kind, a large station; and I have no doubt whatever, that when the system is worked on a large scale, it will be found to contrast, as to *cost*, most favourably with any system of electric lighting, and even with gas itself.

Your obedient servant,

ELECTRON.

Junior Carlton Club,
December 23rd, 1879.

[We have received another important letter on this subject, which arrived too late for publication in the present number; it will, however, appear in our next issue.—ED. TEL. JOUR.]

THE cable between St. Thomas and St. Kitts is interrupted, and as the cables between Antigua and Guadeloupe, and between St. Croix and Trinidad are not yet repaired, there is at present no telegraphic communication with St. Kitts, Antigua, Guadaloupe, Dominica, Martinique, St. Lucia, St. Vincent, Barbadoes, Grenada, Trinidad, Demerara, and Berbice.

Notes.

TELEPHONIC EXCHANGES.—The Lancashire Telephonic Exchange Company (Limited), are busily engaged establishing "Exchanges" in the principal manufacturing towns of Lancashire. Already the company have exchanges at Liverpool and Manchester, and the subscribers at these places are increasing almost daily. At present there are 120 subscribers in Manchester and somewhat more at Liverpool. It is astonishing how popular these exchanges are now becoming, and people wonder why they were not introduced long since. Manchester was shrouded in a thick fog on Monday, the 8th ult., but thanks to the telephone, merchants and others were able to arrange their business transactions without leaving their offices. There was some fear when the telephone was first brought under public notice that it would become simply a wonderful scientific toy, but there can now be no doubt that it will be utilised to an enormous extent, and that it will replace very largely the instruments at present employed on private telegraph lines.

THE CAPE CABLE.—The section of the Cape Cable between Aden and Zanzibar has been laid, thus connecting telegraphically the Cape Colony with the rest of the world.

ROYAL INSTITUTION LECTURE.—The Friday evening lectures at the Royal Institution, before Easter, will include a lecture by Professor Dewar, on "Studies on the Electric Art," on January 16th, and a lecture by Mr. W. H. Preece, on "Wheatstone's Telegraphic Achievements," on February 13th. Dr. C. W. Siemens will lecture on the 12th March.

THE FRENCH ATLANTIC CABLE.—The French Cable, the main portion of which has recently been laid, will have a total length of 3,363 knots. Of this distance, the cable from Brest to St. Pierre, Newfoundland, which has been laid, is 2,395 knots in length. The portion between St. Pierre and Cape Cod, Massachusetts, which has also been laid, is 860 knots long. From Cape Cod to New York the messages will be transmitted by an overland wire, the property of the Company. Another portion of cable, 270 knots in length, has just been laid between St. Pierre and Nova Scotia. It was not intended to finish this portion during the present year, but the rapidity with which it has been constructed has enabled it to be completed. The completion of the total length of 3,663 knots will be effected when the last link, 138 knots in length, is laid between Brest and the Land's End. The completion of the main portion of the cable was heralded by the usual complimentary messages.

REMARKABLE ELECTRIC PHENOMENON.—At the commencement of a violent snowstorm, the author perceived little luminous tufts at the end of the steel rods of his umbrella, and heard a sound like the humming of an insect. On approaching his hand to one of the lights he felt a slight shock in the first two joints, and the light disappeared.—*E. Lamarre, in "Comptes Rendus."*

THE ABERMAWR-WEXFORD CABLE.—Operations in connection with the repair of the Abermawr-Wexford 4-wire cable, belonging to the Postal Telegraph Department, and which was broken a short time ago, have already been commenced. It has been found necessary to renew entirely a portion of this cable. The repairs will be completed early in the present month.

POST OFFICE TELEGRAPHS.—The Postal Telegraph receipts for the months of October and November last

year have exceeded those of the corresponding months in the previous year by no less than £36,378, or nearly 17 per cent.

THE Post Office and Telegraph departments of Queensland are being amalgamated.

UNDERGROUND TELEGRAPHS IN FRANCE. — M. Cochery, the Minister of Posts and Telegraphs in France, recently applied to the Government for a credit of 8,000,000f. for the establishment of subterranean telegraph wires along some of the main trunk lines, to take the place of the existing aërial lines, should the latter become incapacitated by the weather, or any other cause. The total length it is proposed at present to lay is 965 kilometres.

THE BLAKE AND THE EDISON TELEPHONIC TRANSMITTERS.—In a letter to the *Scientific American*, Mr. T. D. Lockwood, of Boston, U.S., says:—

"An attempt is now made to induce the public to believe that Mr. Edison is also the inventor of the only really successful microphonic transmitter ever produced. I allude to that invented by Mr. Francis Blake, of Newton Lower Falls, Mass., and described in your issue under the date of November 1.

"Wherein the similarity between the Blake and the Edison transmitters lies, it is difficult for one acquainted with both to say, save in the fact that both are used in combination with an induction coil, the secondary circuit of which is a part of the main line.

"I have examined Mr. Prescott's account of Mr. Edison's inertia telephone, and find it totally different, both in action and principle, from any microphone.

"It appears, however, from the article in question, that Mr. Edison's latest transmitter, described also in the *Scientific American* a few weeks since, is also like the 'old invention,' in principle. If so, it is a query why the Western Union Company did not bring out this superior instrument instead of the carbon telephone, when the latter was beaten everywhere by the Blake transmitter. The fact really is that the Western Union tried to imitate the Blake transmitter at different times since its introduction, a year since, and could never make the imitations work, simply because the Blake transmitter has a few technical points on which its success depends, and which are only known to the electricians of the National Bell Telephone Company.

"Mr. Prescott states in his book, and it is found to be true in practice, that although many substances may be used as a conducting medium for varying resistances in the Edison transmitter, lampblack is the best; *per contra*, lampblack is not used in the Blake transmitter at all, the substance used being invariably very hard gas carbon, besides which Mr. Edison himself states in his patent 203,016, that unmixed carbon is not adapted for use in his transmitter.

"The article we have alluded to as in your last issue, in its second paragraph states that there is 'nothing delicate or fine about the construction' of the Blake transmitter. In the third paragraph we find the words, 'this casting supports two delicate springs,' &c. One of the main features in this transmitter is the delicacy of the adjustment obtained by means of the casting, which is perpendicularly across the inside of the diaphragm, and the screw in its lower end. In conclusion, I desire to say that no cavilling spirit dictates these remarks, but simply a desire for justice to the Blake transmitter, it inventor, and perfecters."

a lecture delivered at Berlin, on "Electricity in Service of Life," Dr. Werner-Siemens spoke of the problem of the electric transmission of power to a distance. He stated that two cases of the kind existed in the city; in one case looms were driven, and in the other a small locomotive. He also insisted upon the value of electricity for metallurgical purposes, and thought that the solar rays may by-and-by furnish all necessary fuel through the agency of the electric current.

THE METROPOLITAN FIRE BRIGADE TELEGRAPHS.—At a recent meeting of the Metropolitan Board of Works, the Fire Brigade Committee stated that their attention had been called to the necessity of improving the telegraphic communication between some of the fire stations. Delay and inconvenience arose from the fact that some of the outlying stations were not in direct communication with the chief office of the district. It was resolved that immediate steps, at a cost of £225, be taken for the purpose of remedying the difficulty.

THE TIDE AS A MOTIVE POWER.—At the fortnightly meeting of the Liverpool Engineering Society, Mr Arthur Pates, of Bradford, read a paper on the "Utilisation of the Tides." In the course of it he remarked he believed that the "age of steam" had reached i zenith, and the "age of electricity" had dawned. Th author illustrated the paper by drawings, which were lucidly described, showing the proposed method of utilising the power of the tides, and by a table giving the approximate cost of such works.

THE TELEPHONE IN BURTON.—Messrs. Bass & Co., says the *Burton Chronicle*, now possess the most unique and comprehensive telephone department of any private firm in England. A central office has been established on the system of the public telephone exchanges at work in America, and more recently in London, Sheffield, and elsewhere. The wires, some of them nearly two miles in length, twelve in number, and springing from the offices of heads of departments, are terminated in the central office. In this office is also placed a very ingenious yet simple "switchboard," which provides the means of putting the ends of the wires in electrical connection. A series of brass "shutters" are attached to the switchboard, each shutter being engraven with the name of the office with which it is connected. When a distant office desires communication, the shutter on that particular wire falls open. In a moment the operator in the central office, by the insertion of a brass plug, is informed the name of the other office with which communication is wanted. The insertion of another brass plug completes the joining of the two wires together, and the two offices, although miles away, are in oral communication with each other; the whole operation of putting them through having occupied three or four seconds. This vast concern now transacts its business, although covering so much ground, with the ease and freedom of being placed in one large building. It only remains for us to add that the voice of the speaker at the most distant office was as plain and as familiar as if we were face to face, and the extreme sensitiveness of the apparatus was demonstrated by the fact that we heard whispering and the ticking of a watch with remarkable distinctness. A clerk is employed at the central office from 7 a.m. to 6 p.m. simply to attend to the telephone. The whole of the work in connection with the system has been carried out by Messrs. Tasker, Sons, and Co., of Sheffield.

OPTICAL TELEGRAPHY.—The French Minister of War has published regulations for organising optical telegraphy in time of peace. Several places on the French frontier are to be connected by posts, and apparatus are to be manœuvred by trained persons.

who will make reports of communications sent or received. This new service is to be placed under the supervision of the Director of Aërial Communications, who already has command of the balloonists and colombophiles for carrier pigeons.

WESTERN UNION TELEGRAPH COMPANY.—At the close of the year, ending June 30, 1879, the Western Union Telegraph Company had 82,987 miles of line, 211,566 miles of wire, and 8,534 offices. At the close of the year ending June 30, 1869, the corresponding totals were 52,099 miles of line, 104,584 miles of wire, and 3,607 offices. In the year ending June 30, 1879, the company forwarded 25,070,106 messages as compared with 7,934,933 messages in the year ending June 30, 1869.

SAWYER'S ELECTRIC LAMP.—A new electric lamp was recently exhibited in operation at the factory of Arnoux & Hochhausen, manufacturers of electrical lighting apparatus, at Nos. 2 and 4, Howard Street, New York. The lamp is the device of Mr. Charles Sawyer, who exhibited an apparatus called the "Sawyer-Man Lamp" about a year ago. The light of this lamp was produced by the heating to a white heat of a slender, short pencil of carbon, supported in an hermetically sealed glass tube. This tube was filled with nitrogen gas, and contained at its base a preparation which the inventors claimed would prevent the destruction of the carbon pencil. The lamp exhibited is a modification of the Werdemann and the Sawyer-Man lamps. The pencil is eight inches long, is hermetically sealed in a glass tube containing nitrogen, and is fed upward, like the pencil of Werdemann's lamp. Mr. Sawyer claimed that the pencil would need to be fed upward, one-sixteenth to one thirty-second of an inch, once during a period of from nine to fourteen hours, and that the pencil would, therefore, supply light for about 1,500 continuous hours. This result, Mr. Sawyer said, was due to an electrical generator of his own design. The total cost of materials for a year's constant use of the lamp would be 12 cents. Three lamps were exhibited in one circuit, and each gave a good light. Any one light may be extinguished while the others remain unaffected. A company, to be called the Eastern Manufacturing Company, is to be organised in New York for the purpose of introducing the new apparatus. Mr. Sawyer said it is proposed at first to provide sets of lamps consisting of from two to six lamps, each set to be accompanied with an electrical generator and all necessary apparatus. The lamp is designed to be used in the place of gas light, and Mr. Sawyer claims that he has accomplished the necessary sub-division of the light.

THE TELEPHONE AT BIRMINGHAM.—Augustus Westwood & Co., telegraph engineers, of West Bromwich, have erected five lines of wire for Messrs. W. and T. Avery, Birmingham (the eminent scale makers), on which they are using Bell's telephone. The success of the instrument is so great that the firm are in treaty with Messrs. Westwood to erect a line of wire between their works at Birmingham and Ryder's Green, a distance of 10½ miles.

A STORM DETECTOR.—Professor A. Mayer, of the Steven's Institute, U.S., records that while a thunderstorm was raging at so great a distance off that only the illumination of the clouds told when a flash occurred, he attached one wire of a galvanometer to the water-pipes and the other to the gas-pipes of his house, thus connecting in metallic current a vast system of metallic conductors stretching all over the city. Whenever a flash occurred he states that the galvanometer needle was deflected 10° to 20°. The two occurrences were simultaneous, so far as could be determined. The storm was 12 miles distant, and the conclusion drawn was that "at least 500 square miles of the earth's surface had its electrical condition changed at each flash of the lightning."

Proceedings of Societies.

PHYSICAL SOCIETY.—DECEMBER 13th, 1879.
Prof. W. G. ADAMS in the Chair.

New Members—Mr. J. H. POYNTING, Mr. R. T. GLAZEWOOD, Dr. R. C. SHETTLE, Prof. ROWLAND, Mr. JOHN GRAY, D. Sc., Mr. H. R. BROOK, Mr. E. B. SARGENT, Mr. E. PATERSON.

"On the Graduation of the Sonometer," by Mr. J. H. Poynting, Trinity College.

The author had endeavoured to reduce the present arbitrary readings of the sonometer of Prof. Hughes to absolute measure by adopting the formula given in Maxwell's *Electricity*, vol. ii., chap. xiv., to the induction of two circular coils on the same axis separated by a distance greater than the radii of the coil, on a third coil intermediate. By applying the formula thus obtained to the results of Prof. Hughes for different metals, he finds that either the electric resistance of metals as given in the tables is not the same as the resistances of the metals as employed by Prof. Hughes, or that the induction effect of the balance or sonometer is not proportional to the conductivity of the metal.

Prof. AYRTON reminded the society that, at a former meeting, he had shown mathematically that the effect was not proportional to the conductivity but to an exponential function of the conductivity. W. CHANDLER ROBERTS, F.R.S., stated that Prof. Hughes did not profess that the metals used by him to obtain his results were pure. Prof. ADAMS mentioned that Prof. Hughes had shown that the effect was dependent on other conditions than the mere purity of the metal.

Dr. G. A. FLEMING, St. John's College, Cambridge, exhibited and described a new form of Wheatstone balance, designed principally for comparing the B. A. units of resistance deposited in the Cavendish Laboratory. The divided resistance is a circular platinum-iridium wire, and an arm fitted with a contact at its extremity revolves round after the manner of circular resistance coils, thus altering the ratio of the divided resistances. The contact is a knife-edge of platinum, and it is made and broken by hand like a key. A series of ingenious copper mercury-cups are fitted to the balance so as to permit of two coils being compared at any temperature with great exactness by the method suggested by Prof. Foster and adopted by Prof. Chrystal of Cambridge. This consists in exchanging the positions of the units on the balance and observing the difference in the results. By Dr. Fleming's arrangement this exchange can be effected without removing the coils from the heating apparatus in which they are placed or otherwise altering their conditions. The mercury contact-cups, and the heating cans were also improved by Dr. Fleming for the purpose of facilitating accuracy of results.*

Prof. PERRY described a Dispersion Photometer devised by himself and Prof. AYRTON, for the purpose of comparing intense lights, such as the electric, with a standard candle, without taking up much room in order to put the stronger light a distance from the screen proper, to give an illumination equal to that of the candle.

* A full illustrated description of this Balance is given on page 3 of this Journal.

To reduce the distance of the stronger light from the screen, the authors had inserted a lens in the track of the beam, so as to disperse the beam to a degree which could be determined by an easy formula. Thus by artificially diluting the powerful beam they could compare it with the feebler beam, from the standard light, in a shorter space. For an electric light of 6,400 candles only 8 feet need be required by the new plan, instead of 80 feet by the unassisted method.

Dr. JOHN HOPKINSON, F.R.S., stated that he had actually used the same method for some months past in his electric light experiments. He recommended a plano-convex lens as the best to use; and suggested that the focal length should be calculated. He thought that the error due to absorption could easily be obviated.

Prof. AYRTON then described a method by which Prof. PERRY and he had determined the value of g, or the co-efficient of gravity, at the Imperial Engineering College, Tokio, Japan, by means of pendulums. Their result is 980·06; and calculation from the position of the place makes it 979·8.

An improved form of Spherometer, designed by Mr. W. GOOLDEN, and made by Mr. ADAM HILGAR, was exhibited to the meeting. The frame is of aluminium, combining lightness and rigidity; the legs and screws of hard steel. The screw carries a drum, divided into 1,000 parts, and the instrument gives a reading to the $\frac{1}{100000}$ of an inch by the usual method of touch. Increased sensitiveness is got by employing a galvanometer to indicate the contact of the middle pointer with the surface. By this means it is made correct to $\frac{1}{100000}$ of an inch.

New Patents—1879.

5009. "Friction telephones; or, electromotographs." J. IMRAY. (Communicated by J. F. Bailey.) Dated Dec. 6. Complete.

5044. "Improvements in wire drawing and apparatus therefor." J. IMRAY. (Communicated by P. Muhlbacher.) Dated Dec. 9.

5045. "Inclinatoriums; or, dipping azimuth compasses." J. IMRAY. (Communicated by J. Peichl.) Dated Dec. 9.

5078. "Improvements in, and relating to, electrical signal apparatus." W. R. LAKE. (Communicated by F. Blake.) Dated Dec. 11.

5085. "Dynamo electric machines, and electromotive engines." W. L. WISE. (Communicated by E. Bürgin.) Dated Dec. 11.

5114. "Improved methods of, and apparatus for, facilitating telephonic communication." W. R. LAKE. (Communicated by M. D. and T. A. Connolly and T. J. McTighe.) Dated Dec. 13.

5119. "Electric telegraphs." SIR J. ANDERSON and F. S. HARRGOOD. Dated Dec. 13.

5126. "Electric signalling apparatus to be used in the loading and discharging of ships." W. WHITE. Dated Dec. 15.

5127. "Improvements in electric lamps; and in the method of manufacturing the same." T. A. EDISON. Dated Dec. 15.

5149. "Telephones and their connections." J. IMRAY. (Communicated by J. F. Bailey.) Dated Dec. 16. Complete.

5153. "Signal buoys." E. E. MANN. Dated Dec. 16.

5156. "Electric light regulators." S. PITT. (Communicated by C. E. Scribner.) Dated Dec. 16.

5157. "Magneto-electric machines and electric light apparatus." H. F. JOEL. Dated Dec. 16.

5167. "Safety alarm signalling apparatus to be used in connection with steam boilers." W. WHITE. Dated Dec. 17.

5175. "An improved mode of insulating mariners' compasses." A. W. L. REDDIE. (Communicated by J. B. Siccardi.) Dated Dec. 17.

5196. "Apparatus for ringing alarm bells on floating buoys at sea or in harbours." S. PITT. (Communicated by H. Brown.) Dated Dec. 19. Complete.

5206. "Improvements in, and connected with, electric lamps." G. G. ANDRÉ. Dated Dec. 19.

5219. "Galvanic Batteries." T. COAD. Dated Dec. 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

1635. "Electric light apparatus." JAMES MCKENZIE, of the firm of Strode and Company. Dated April 25. Relates to improvements in apparatus for governing the distance between the points of the electrodes, or carbons of electric lamps, where they are arranged vertically, or opposite to each other.

1652. "Improvements in, and relating to, printing telegraph apparatus." WILLIAM ROBERT LAKE. (A Communication from abroad, by Casimir Hayet, of Paris.) Dated April 26. 8d. This invention consists of modifications of the ordinary dial apparatus. In order to adapt it for printing, it is necessary that the manipulator shall be an invertor, and the receiver consequently provided with a polarised pallet, and without spring regulation. The magnetic connecting bar of the line electro-magnet is replaced by a non-magnetic bar, or piece of copper, for example. Two electro-magnets are thus obtained with one branch, placed in juxtaposition in the same circuit, and having consequently four poles, of which two are utilised for the rotation of the type wheel and of the needle, and two for the impression.

1692. "Regulating electric currents." JOHN SCUDAMORE SELLON and HENRY EDMUNDS. Dated April 30. 6d. Great difficulties have hitherto been experienced in controlling the energy of the electric current, as, for example, in electric lighting by the incandescence of a rod or wire. Moreover, the motive force required to work the dynamo-electric machine has been, to a great extent, wasted when the electric current has proved too powerful for the work it was required to perform, the practice of shunting off the excess of electricity having been adopted, instead of the action of the motor being reduced. It is now proposed to introduce into the circuit an automatic switch, which, as a retaining or other wire, forming part of the switch, becomes heated by the passage of the current, will be brought into action and caused to connect the two collecting brushes of the dynamo-electric machine with each other, thereby causing the induced current to cease, and free the motive power engine of its work.

1766. "Demagnetising iron ships." EVAN HENRY HOPKINS. Dated May 5. 2d. Consists in the application of electro-magnets of a special construction to the framework of iron ships, or to the iron framework or structure of composite ships. (*Not proceeded with.*)

1791. "Electric lamps." JOHN SCUDAMORE SELLON and HENRY EDMUNDS. Dated May 6. 2d. Relates to regulating the energy of the electric current to each lamp in a circuit, by supplying all the lamps in a circuit with the maximum current required to secure the proper incandescence of any one of the lamps, and in such of the lamps as may not require the full current, by connecting

the two sides of the space bridged over by the incandescent wire, by passing as many fine wires from side to side as may be found necessary to carry over the surplus current. Also it consists of an arrangement for closing the circuit and cutting out any lamp of a series before the fusing point of the incandescent wire is reached; and, lastly, to a lamp in which two illuminating rods or wires are used, the second one being brought into circuit on the fusion of the first. (*Not proceeded with.*)

1813. "Electric type printing telegraph apparatus." GEORGE JONAS DROSTE. Dated May 7. 8d. Is intended to overcome the difficulty of obtaining synchronism in the driving mechanism of the Hughes' apparatus, which, it is stated, is increased when more than two apparatus are to be worked on one circuit, and with a greater number becomes an impossibility. The synchronism of the apparatus in a circuit is ensured by the mutual action of the electro-magnets and the driving mechanisms, which latter are connected with automatic current commutators and influence the same. (The claims are fourteen.)

1830. "Apparatus for composing, transmitting, and deciphering secret telegrams." HERBERT JOHN HADDAN. (A communication from Messrs. G. Schacher et Compagnie, of Paris.) Dated May 8. 2d. Consists in or of several alphabets or signs arranged on concentric circles on a transmitting or recording dial, on which circles the same letters or signs have different values given them, following some key. (*Not proceeded with.*)

1949. "Apparatus for generating electric currents." JOHN SCUDAMORE SELLON and HENRY EDMUNDS. Dated May 15. 2d. The object of this invention is to obtain induced currents of electricity (by the aid of rotating magnets), that these currents may be used for illuminating and other purposes without affecting the current which circles around the field magnets. (*Not proceeded with.*)

MR. SAM MENDEL has joined the board of the Western and Brazilian Telegraph Company (Limited), as deputy-chairman.

Messrs. C. J. Hambro and Son notify that a half-yearly dividend at the rate of 5 per cent. per annum will be paid on the shares of the Great Northern Telegraph Company on and after to-day.

The offices of the Indo-European Telegraph Company have been removed to 18, Old Broad Street, E.C.

The Eastern Extension Telegraph Company (Limited), have declared an interim dividend for the quarter ending Sept. 30 last of 2s. 6d. per share, or at the rate of 5 per cent. per annum, free of income tax.

The Eastern Extension, Australasia and China Telegraph Company (Limited), notify that the coupons on the Five per Cent. Australian Government Subsidy Debentures, due to-day, will be paid on and after that date at Messrs. Barclay, Bevan and Co.'s.

The following are the final quotations of telegraphs for Dec. 29th:—Anglo-American, Limited, 57-57⅛; Ditto, Preferred, 82-82½; Ditto, Deferred, 33⅛-33; Brazilian Submarine, Limited, 7½-7¾; Cuba, Limited, 8½-9; Cuba, Limited, 10 per cent. Preference, 15½-16½; Direct Spanish, Limited, 2¼-2¾; Direct Spanish, 10 per cent. Preference, 12-12½; Direct United States Cable, Limited, 1877, 10¼-10¾; Eastern, Limited, 8⅝-8⅞; Eastern, 6 per cent. Debentures repayable Oct., 1883, 102-104; Eastern 5 per cent. Debentures repayable Aug., 1878, 102-104; Eastern, 6 per cent. Preference, 11¾-12; Eastern Extension, Australasian and China, Limited, 8¼-8½; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 101-103; Ditto, registered, repayable 1900, 102-104; German Union Telegraph and Trust, 8¼-8¾; Globe Telegraph and Trust, Limited, 5-5¼; Globe, 6 per cent. Preference, 11-11½; Great Northern, 8⅞-9⅛; Indo-European, Limited, 22½-23½; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10-10½; Reuter's Limited, 10-11; Submarine, 225-235; Submarine Scrip, 2⅛-2⅜; West Coast of America, Limited, 1¼-1¾; West India and Panama, Limited, 1⅜-1⅝; Ditto, 6 per cent. First Preference, 7¼-7¾; Ditto, ditto, Second Preference, 6½-7; Western and Brazilian, Limited, 5⅜-5⅝; Ditto, 6 per cent. Debentures "A," 99-102, Ditto, ditto, ditto, "B," 97-101; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 105-107; Telegraph Construction and Maintenance, Limited, 34-36; Ditto, 6 per cent. Bonds, 106-108; Ditto, Second Bonus Trust Certificates, 2¾-3; India Rubber Co., 12¾-13¼; Ditto, 6 per cent. Debenture, 105-107.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
Nov., 1879 ...	67,380	*14,540	3,000	1,335	22,460	46,147	26,379	16,653	... ...	*a*	**	*12,337	4,707
Nov., 1878	51,090	12,753	2,609	1,002	17,030	37,170	25,980	16,587	... ...	9,549	2,200	... ..	4,729
Increase	16,290	1,787	391	333	5,430	8,977	1,099	66	... ...	... ...	... ...	... ...	... ...
Decrease	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	22

* Four weeks. ** October receipts, £12,000. *a*, not published at present.

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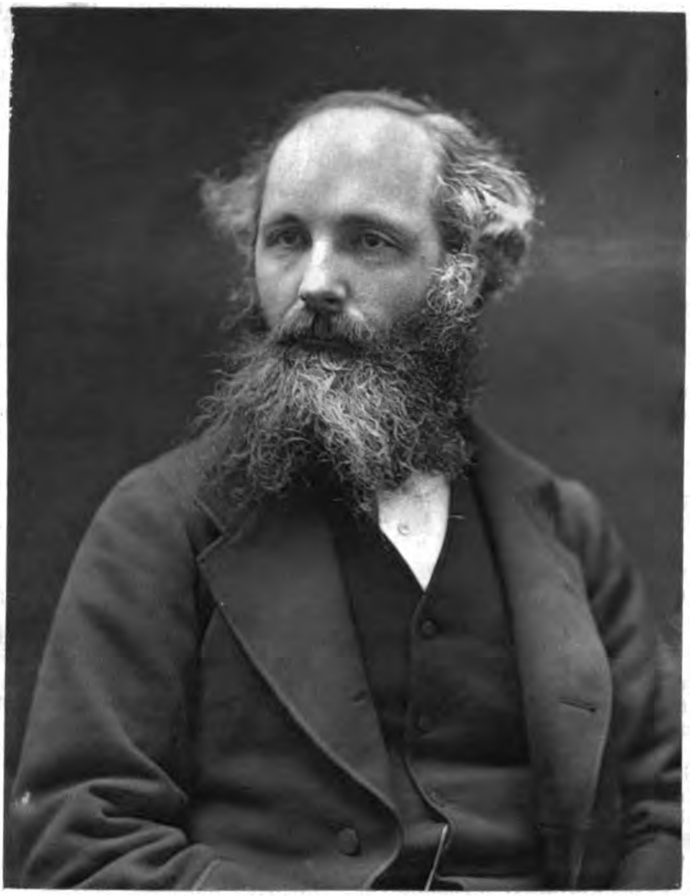

Reproduced by Woodbury Permanent Process from a photograph by Mr. C. Fergus, of Greenock.

JAMES CLERK MAXWELL, F.R.S.*

JAMES CLERK MAXWELL was born in 1831, being the only son of John Clerk Maxwell, Esq., of Middlebie. His grandfather was Captain James Clerk of Penicuik, whose two sons were the Right Hon. Sir George Clerk, Bart., of Penicuik, and the above-mentioned, John Clerk Maxwell. Captain James Clerk was a younger brother of Sir John Clerk of Penicuik, and on the death of the latter, Sir George Clerk succeeded to the estate of Penicuik, while John succeeded to the

* This being the best memoir of Professor Maxwell written, we are induced, with the permission of the Editors of *Nature*, to reprint it in full. We are also indebted to the author for his kindness in revising same.—ED. TEL. JOUR.

estate of Nether Corsock, part of the Middlebie estate, which had come into the family through marriage, in a previous generation, with Agnes Maxwell. Along with this estate John Clerk assumed the family name of Maxwell. When James Clerk Maxwell was eight years old his mother died, and his father, who had been called to the Scotch Bar, but never practised as an advocate, lived a retired life, devoting himself to the care of his estates, and of his son.

James Clerk Maxwell was educated at the Edinburgh Academy, where he gained the Academical Club Medal for Geometry in 1845, and the Silver Medal for Mathematics in 1847. In 1848 his mother's brother, John Cay, of Edinburgh, took him to see William Nicol, who showed him the colours exhibited by polarised light after passing through unannealed glass, &c. This visit seems to have given the first impulse towards his researches in optics. On his return he constructed a polariscope with glass reflectors. The framework of the first was of cardboard, but a superior article was subsequently constructed by him in wood. Small lenses mounted in cardboard were employed when a conical pencil of light was required. By means of this instrument he examined the figures exhibited by pieces of unannealed glass which he prepared himself, and with a camera lucida, and a box of water colours, he reproduced these figures on paper, taking care to sketch no outlines, but to shade off each coloured band imperceptibly into the next. Some of these water-colour drawings he forwarded to Nicol, and was more than repaid by the receipt shortly afterwards of a pair of prisms prepared by Nicol himself. These prisms were always very highly prized by Professor Maxwell. Once while at Trinity the little box containing them was carried off by his bed-maker during a vacation, and destined for destruction. The bed-maker died before term commenced, and it was only after a very diligent search that they were found among the late bed-maker's effects, which had been set aside as valueless. After this event the prisms were most carefully guarded, and they have recently been deposited, at Professor Maxwell's request, in one of the show cases of the Cavendish Laboratory. The study of the figures exhibited by unannealed glass in polarised light drew the attention of Clerk Maxwell more particularly to the equilibrium of elastic solids, a subject on which he has done some very valuable work.

After leaving the Edinburgh Academy, James Clerk Maxwell entered the University of Edinburgh, where he soon won the esteem of Kelland, Forbes, and Gregory, under whom he studied and worked. In October, 1850, he came to Cambridge, entering at Peterhouse. At this time his father does not seem to have been very sanguine respecting the advantages to be derived from a Cambridge course, but his opinion of the University rose considerably when in 1854 the examiners showed their appreciation of his son by making him Second Wrangler, and bracketing him as first Smith's Prizeman. Clerk Maxwell remained but one term at Peterhouse. There was little chance of his obtaining a Fellowship without considerable delay, on account of the few vacancies likely to occur, and this consideration induced his college tutor, purely out of regard to Clerk Maxwell's interest, to recommend his migration. Other considerations, however, seemed to influence Clerk Maxwell himself. In every college there are always idlers to be found, who amuse themselves by "dropping in" upon men at all hours. In a large college a man selects his own friends, and the idlers can indulge their favourite habit with the least possible injurious effect by "dropping in" upon one another. But in a small college, where all the undergraduates are known to one another, and in the case of a student like Clerk Maxwell, to whom it was impossible to grieve any one, the evil reached a maximum. He, therefore, migrated to Trinity, which he entered on December 14th, 1850, and here, having a much larger number to select from, he not only found congenial spirits, but soon became looked up to as their leader by a set of admiring followers. In 1852, while an undergraduate at Trinity, he stayed for a few weeks at a country vicarage in Suffolk with the Rev. C. B. Taylor, a brother of a college friend. While there he was attacked by a serious illness, and the care and kindness with which he was nursed by Mr. and Mrs. Taylor never faded from his memory; it so impressed him with the power of love that it formed an important factor in the formation of the Christian character which all who knew regarded with an admiration akin to worship.

As above stated, James Clerk Maxwell graduated as Second Wrangler and (bracketed) first Smith's Prizeman in 1854, having previously been elected a Foundation Scholar of his College. In 1855 he became a Fellow of Trinity, and in 1856 obtained the Professorship of Natural Philosophy in Marischal College, Aberdeen, which appointment he held till the fusion of Marischal College and King's College, when he, with other Professors, received a pension from the Crown. In 1858 he married Katherine Mary, a daughter of Principal Dewar of Marischal College, thus vacating his fellowship at Trinity. In 1860 he succeeded Professor Goodeve as Professor of Natural Philosophy and Astronomy in King's College, London, but after the death of his father he retired in 1865 to his estate in Scotland, where he subsequently carried out his father's plans for completing the house and offices at Glenlair. In 1871 he was invited by the Senate of the University of Cambridge to accept the Chair of Experimental Physics which had just been created, and on October 25th, 1871, he delivered his inaugural lecture as Professor of Experimental Physics in the University of Cambridge. At first the most important part of his work consisted in arranging the details of the Cavendish Laboratory which the Duke of Devonshire had offered to present to the University, and the building of which was personally superintended by Professor Maxwell from first to last. The whole of the arrangements which rendered the Cavendish Laboratory so admirably adapted for physical investigations, are due to the care and forethought of Professor Clerk Maxwell. When the building had been completed and formally presented to the University, the Duke of Devonshire further signified his desire to provide it with a complete equipment of apparatus, and all this was procured under the personal supervision of the Professor. In 1872 he was elected Honorary Fellow of Trinity College, Cambridge.

During last winter Professor Maxwell did not

enjoy his usual health. In the spring he was unable to carry on his work with his accustomed vigour, but when he left Cambridge for Scotland his friends supposed that with mental rest and physical exercise his health would be restored, and did not regard his indisposition as other than temporary. In Scotland, however, his health did not improve, he suffered much pain and was unable to take his usual food. At length by the advice of his medical attendants, and of Professor Saunders of Edinburgh, one of his former fellow-students, he returned to Cambridge in the beginning of October. Under Dr. Paget's care he at first made considerable improvement and some hopes were entertained of his recovery. He, however, gradually became weaker, and when Dr. Humphry visited him in conjunction with Dr. Paget, it was plain that medical skill could only alleviate his suffering. He died at noon on Wednesday, November 5th, having retained the conscious possession of all his mental powers to the last.

General invitations were sent to all members of the electoral roll of the University to assemble in Trinity College Chapel at 4.30 p.m. on Monday, Nov. 10th, and were numerously accepted, especially by heads of houses (including the Vice-Chancellor), and by professors. About 4.45 p.m. the service was commenced by Mr. Stanford playing the "Dead March" upon the organ. The remains of the late professor were then carried into the chapel, preceded by the choir, and the first part of the Burial Service read. This was followed by the anthem, "If we believe that Jesus died and rose again, even so them also which sleep in Jesus shall God bring with him. . . . Wherefore comfort one another with these words." After the service the assembly followed the body to the great gate, whence it was conveyed to Scotland to be interred in the family burying-place at Corsock, Kirkcudbrightshire.

Professor Maxwell was appointed Foreign Honorary Member of the American Academy of Arts and Sciences of Boston in November, 1874; Member of the American Philosophical Society of Philadelphia in October, 1875; Correspondent in the Mathematical Class to the Imperial Academy of Sciences, Göttingen, in December, 1875; Honorary Member of the New York Academy of Sciences, in December, 1876; Associate of the Amsterdam Royal Academy of Sciences in April, 1877; and Corresponding Member of the Imperial Academy of Sciences, Vienna, in August, 1877. He was Fellow of the Royal Societies of London and Edinburgh, and of the Cambridge Philosophical Society, and a large contributor to the Transactions of each of these. In 1872 he was created Honorary LL.D., of Edinburgh, and on June 21, 1876, he received the honorary degree of D.C.L. at Oxford.

In 1860 the Rumford Medal of the Royal Society was awarded to Professor Clerk Maxwell "for his Researches on the Composition of Colours, and other Optical papers." In his address on the presentation of the medal, Major-General Sabine alluded to Professor Maxwell's calculation showing the connection of the "mechanical strains to which elastic solids are subjected under certain conditions with the coloured curves which those solids exhibit in polarised light." He then alluded to the colour-top of Professor Maxwell, and the colour-equations obtained from it, as well as the light it throws upon colour-blindness, concluding with these words:—"These researches for which the Rumford medal is awarded lead to the remarkable result that to a very near degree of approximation all the colours of the spectrum, and therefore all colours in nature, which are only the mixtures of these, can be perfectly imitated by mixtures of three actually attainable colours, which are the red, green, and blue, belonging respectively to three particular points of the spectrum."

(To be continued.)

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.*

I.

PREVIOUS to the transfer of the telegraph systems of the United Kingdom into the hands of the State, the apparatus in use was of various types and patterns; this arose from the fact that each telegraph company preferred to have instruments which they considered were best adapted for their own particular requirements. The transfer of the companies to the State necessarily involved a remodelling of the arrangements in existence, so that the system, as a whole, could work harmoniously. At first but few changes could be made, but as time went on, and extensions were erected, a gradual reduction in the diversity of the instruments was effected, so that, finally, a few distinct and uniform groups of apparatus were adopted for general use, together with a certain number of combinations of particular instruments which were necessary for particular purposes.

Very great improvements were effected when the old forms of instruments were remodelled, and at the present time the apparatus employed is in a highly efficient condition, and is well adapted for the purposes for which it was designed, though, of course, from time to time, further improvements are effected, such as experience and the ingenuity of the engineering staff are able to effect.

THE SINGLE NEEDLE INSTRUMENT.

The single needle instrument is practically merely a vertical galvanometer with keys, or pedals, for reversing the direction of the current through the same. In the form of instrument which is now but little used in the postal service, but which still finds favour with the railway companies, the reversing of the current was effected by means of a drop handle, which was worked from side to side by the hand which grasped it. These "drop handle" instruments, as they are called, were those originally employed by the "Electric and International" Telegraph Company, whose offices were, for the most part, at railway stations. The "Magnetic" Company, which was the second largest company in existence at the time of the transfer of the telegraphs to the State, worked very largely a form of instrument known as the "Bright's Bell," which will be described in a future article. The transmitting portion of this instrument consisted of two pedals, by which the battery current was sent in one direc-

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tion or the other. Now the taking over of the two companies, amongst others, by the State, and the large extensions to small country towns which resulted therefrom, necessitated the use of a large number of single needle instruments being brought into use, this form of instrument being easily worked and easily maintained, and as the clerks of the Magnetic Company under the new state of affairs were necessarily called upon, amongst their other duties, to work the instruments in question, it was considered advisable in all the new postal offices to adapt the "Bell" pedal or "tapper" key to the new single needle instruments, as the "Magnetic" clerks were accustomed to its use; this was accordingly done. At the railway offices, where the drop handle instruments were largely used, it was not considered advisable to make any alteration, as the clerks at those different offices were accustomed to their use, hence arises the fact that the "tapper" single needle is at present the form universally used in the postal offices, and the "drop handle" the form used in the railway offices.

"THE TAPPERS."

The design of an efficient form of "tapper" for reversing the current may appear to be a very simple matter, and theoretically no doubt it is so, but practically there are a very large number of points in connection with the design which are of importance if the working of the tapper is to be easy, certain, and also, as far as possible, noiseless. The easy motion of the tapper is a point by no means to be overlooked; nothing is so disagreeable as working an apparatus of the kind which gives a jar to the hand or fingers each time a tapper is depressed. The action must be certain, that is, it must not be liable to miss making contacts when being worked rapidly or with comparatively light pressure exerted on the tappers. Also the action should be, as far as possible, noiseless; the loud rattling of metal against metal in a small office where but few instruments are used is highly unpleasant, in a large office it would be intolerable.

The form of tappers now very largely adopted in the single needle instruments of the Postal Telegraph Department effects all the requirements in a very satisfactory way, and very rarely indeed gets out of order.

Fig. 1 shows a perspective view of the tappers as they appear removed from the case of the instrument of which they form a part. Fig. 2 is a plan of the same showing how the different parts are connected, together, and to the battery and needle dial.

Each of the pedals, or tappers, E, F, is of ebony, and is hinged or pivotted to brass blocks, P, P, screwed firmly down on a teak base. The two blocks are insulated from each other by a piece of ebonite, *e*, shown on fig. 2 by the thick black line. The steel pivots which form the hinges run through brass blocks screwed firmly to the pedals. The screws which secure the brass blocks to the pedals have square brass washers under their heads, shown by the wide shaded lines; the screws can thus be screwed very firmly home, and this adds considerably to the strength of the pedals, whilst a solid and substantial hinge is formed which cannot easily be damaged or stick.

In the front part of the pedals, brass cocks *f* and *g* are firmly screwed, the screws passing through the wood and screwing into brass pieces underneath each pedal. Platinum-tipped screws are screwed on these cocks and make contact, when a pedal is depressed, with the ends of the spring *v*, *v'*, which are immediately beneath them. This spring is secured at its middle by two screws to a brass block screwed to the base of the apparatus, and its ends immediately beneath the platinum-tipped screws are themselves faced with platinum. The ends of this spring are slightly bent up, so as to be clear of the brass block to which it is secured.

The downward play of the pedals is limited by the felt-faced wooden block K, which is secured to the base of the apparatus. The platinum-tipped screws in the brass cocks, *f*, *g*, are screwed down sufficiently to enable contact to be made with the ends of the spring, *v*, *v'*, and for the latter to be depressed when the pedal banks fairly down, or nearly so, on the felt block. The play given to the ends of the spring, *v*, *v'*, ensures good contact being made.

To the back ends of the pedals are brass prolongations, *t*, *t'*, of the axle blocks; the projections are platinum-faced at the upper and lower parts of their ends. These lower platinum faces normally make contact with two brass blocks, *k*, *k'*, of which *k* is seen in fig. 1. The two blocks are kept connected together by means of a brass strap fixed by thumb screws, X, Y; the use of this strap will be explained hereafter. The pedals are held in their normal position by adjustable springs, *m*, *m'*, which can be tightened or loosened by unscrewing screws connected to them.

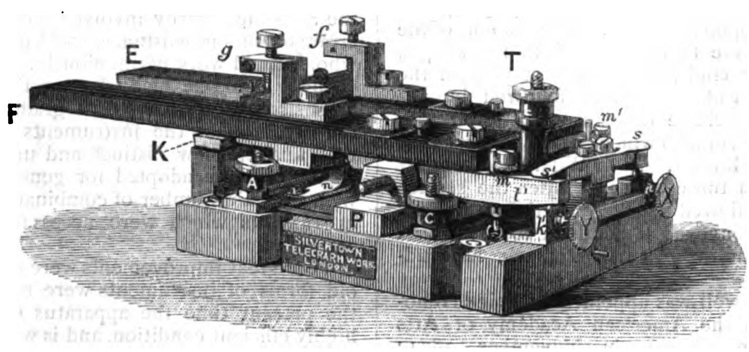


FIG. 1.

The play of the keys is of course finally limited by the height of the felt-faced block, K, also by the back blocks, *k*, *k'*, and, as regards actual regulation, by the screws passing though the cocks, *f*, *g*. These latter screws must be screwed down, so that when the pedals are well pressed down they make firm contact with the ends of the spring v, v^1, it being seen at the same time that the projections, t, t^1, at the back of the pedals make good contact and slightly raise the ends of the spring, s, s^1.

The connections of the various parts of the key will best be seen by reference to fig. 2.

There are 4 terminals, Z, C, A, and T; the three former are marked by ivory labels, the latter has no distinguishing mark.

Terminal Z is connected by a brass strap with the brass block, *h*, to which the spring, v, v^1 is screwed.

Terminal C is connected to the block supporting the spring, s, s^1.

Terminal T is connected with the hinge block of the left-hand pedal, and to the cock, *g*, on the right-hand pedal, by means of a brass strap running on the base of the apparatus. This strap passes under the right-hand pedal and is finally connected to the cock, *g*, by a curved brass spring, *n*, shown in fig. 2.

Terminal A is connected in a similar way to the foregoing, to the hinge block of the right-hand pedal, and to the cock, *f*, of the left-hand pedal.

Action of the tapper.

Supposing the left-hand pedal to be depressed, then the Zinc pole of the battery becomes connected to the block *h*, and thence by the end of the spring *v*, to the cock *f*, thence to terminal A and on to the "Up" line of the circuit. The Copper pole of the battery being in connection with the block supporting the spring, s, s^1, becomes connected with the projecting piece *t*, and thence through the hinge block with terminal T, and from there through the dial of the instrument on to terminal B and the "Down" line.

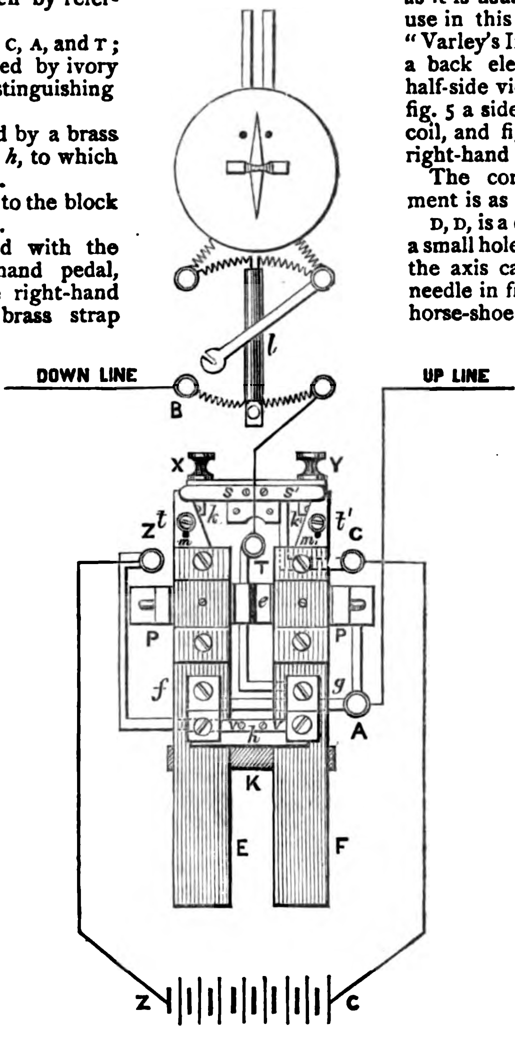


FIG. 2.

If the right-hand pedal be depressed the zinc pole of the battery becomes connected with the cock, *g*, thence with terminal T, and through the dial with the "Down" line. The Copper pole C becomes connected through the end of the spring, s^1, with the prolongation, *t'*, thence through the hinge block with terminal A and the "Up" line; thus the direction of the current is reversed.

The connections shown are those for an "Intermediate" station. If the instrument is at an "Up" station, then the terminal A must be put to earth, terminal B being connected to line. If the instrument is at a "Down" station, the terminal A must be put to line, and terminal A to earth.

London is an "Up" station to all circuits in direct connection with it.

THE DIAL.

The "Dial" or "Single Needle Coil," as it is usually called, now in universal use in this country, is that known as "Varley's Induced Coil." Fig. 3 shows a back elevation complete; fig. 4 a half-side view with the coils removed; fig. 5 a side elevation of the left-hand coil, and fig. 6 a back elevation of the right-hand coil.

The construction of the arrangement is as follows :—

D, D, is a circular brass dial-plate, with a small hole in the centre through which the axis carrying the brass indicating needle in front of the dial and the thin horse-shoe soft iron needle, *h*, passes. The axle is pivotted in front of the dial to a brass bridge screwed to the dial; the inner end turns in a hole drilled in the screw, P; the latter screws into the centre of the brass plate, A, A, which is secured to a similar brass plate, B, B, by the round brass rods seen in fig. 4, so that the whole forms a frame. The dial, D, D, is secured to the brass plate, B, B, in the following manner :—A round but conical-shaped hole is formed in B, B; a round piece of brass *b*, also conical-shaped, fits in this hole so that it can turn in it stiffly, but not pass through it. This round brass piece is screwed to the dial-plate, D, D, by two screws, the whole arrangement, therefore, is such that D, D, can be turned round to any angle if required; this is necessary in order that the front needle may be made to stand always equidistant between the two ivory stops when it is working. If the position of the needle were always vertical, there would be no necessity for the dial-plate being made movable, but it often happens that an earth current will for a time give the needle a permanent list over to one side of the dial or the other, so that working would become impossible if the provision to get over this difficulty was not made by enabling the dial to be turned round to the necessary angle.

The inducing coils c, c′, are shown in position in fig. 3; they are secured to the frame in slots, *s*, *s′* by means of thumb-screws, *t*, *t′*; the right-hand coil is drawn with its silk protecting covering removed, to show the wire wound on it.

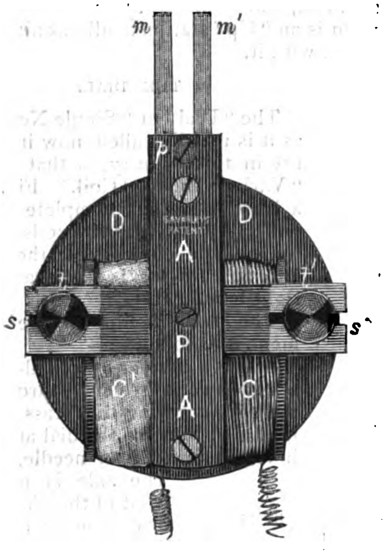


FIG. 3.

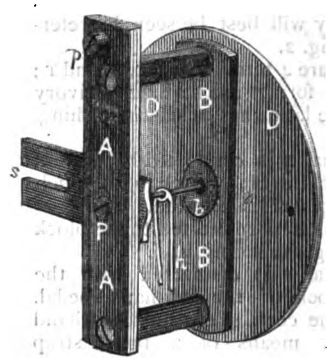


FIG. 4.

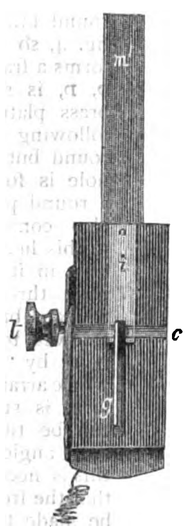


FIG. 5.

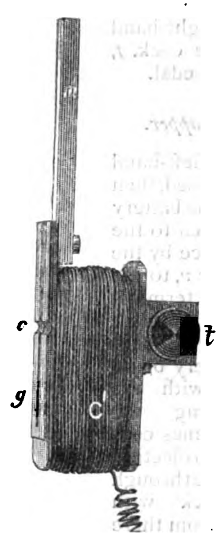


FIG. 6.

Fig. 6 shows a back view of the right-hand coil which is removed from the frame. Fig. 5 shows a side view of the left-hand coil. The frames of these coils on which the wire is wound are of brass; but into each of them is let a piece of soft iron, shown by *i*, fig. 5; this piece of iron is flush with, in fact, forms a part of, the brass cheeks of the coils. A small channel, *c*, is filed in each inner coil cheek face, and in this the axis of the needle is enclosed when the coils are fixed in position.

m, *m′* are two steel permanent magnets which are screwed to the iron portion of the coil cheeks; these magnets act by induction on the soft iron pieces,

and render the ends of the latter, which abut on the channels, *c*, *c*, of the coils, highly magnetic, consequently when the coils are in position, the horseshoe needle, *h*, fig. 4, becomes also magnetised powerfully by induction, as its upper part is in close proximity to this magnetic pole.

The inner ends of the wire wound on the coils are soldered to the insides of the frames so that when the two coils are in position they are electrically connected through the metal work of the frame.

The wire on the coils which is found to give the most satisfactory results is No. 35, B. W. G.; the quantity wound on the two coils together gives a total resistance, of about 200 ohms, whilst the sensitiveness of the arrangement is such that a current from 1 Daniell cell flowing through a total resistance in the circuit of 3000 ohms., that is to say, a current of $\frac{1}{3000}$ webers, or $\frac{1}{3}$ milliwebers, will deflect the needle up to the ivory stops.

The needle in front of the dial, as was pointed out before, is of brass, but the upper portion is of thicker metal than the lower, so as to counterbalance the weight of the soft iron needle inside the coils.

The good pivotting of the axle is an important point, for if this is not good the needle instead of moving freely and hanging vertically will appear to move stiffly and will tend to remain partially deflected over on the side to which it is last moved, instead of returning to its normal position. The pivots which are found to answer best are shaped somewhat like the end of a newly-cut pencil, that is to say, they are formed by tapering off the ends of the axle to a point, the taper not being straight but concave. This form gives great freedom of motion to the needles.

A general front view of the dial, and the way it is connected up to the tappers, is shown in fig. 2. In this fig., *l* is a lightning protector, whose construction will be explained in due course. The four terminals to which the dial, lightning protector, and tappers are connected, are fixed to the back of the instrument case. The dial itself is set in position by the brass plate, A, A, figs. 3 and 4, being slid into a grooved brass piece secured to the instrument case, the pin *p* preventing it from sliding down too far; this arrangement enables the dial to be removed when required with great facility.

The tappers and dial being fixed in position in their respective places on the base and back of the instrument case, and the wires connected up, the front part of the case, which is made movable, is put in its place and secured by two brass thumbscrews; the whole instrument is then ready for use.

SLATER'S IMPROVED BATTERY.

THE commercial value of certain salts is largely in excess of the value of the amount of metal and acid from which they may be produced; this is notably the case with certain salts of nickel, whose value, weight for weight, is about equal to that of the metal from which they are manufactured; but inasmuch as a pound of nickel, by combination with an acid, can produce an amount of salt equal to about six times the weight of metal consumed, it follows that, if the salt can be produced easily, and the acid from which the salt formed be very cheap, that a considerable margin of profit will remain to repay the manufacturer of such salts.

The use of zinc for the positive electrode in galvanic batteries has been almost universal; and although it was well known that other metals could be used for the purpose, their high price, as compared with zinc, has hitherto entirely precluded their employment. The dissolution of zinc in a battery, as

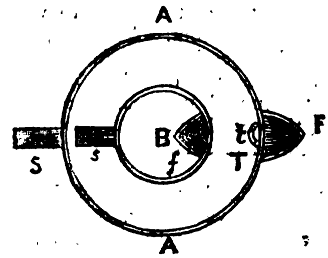


FIG. 1.

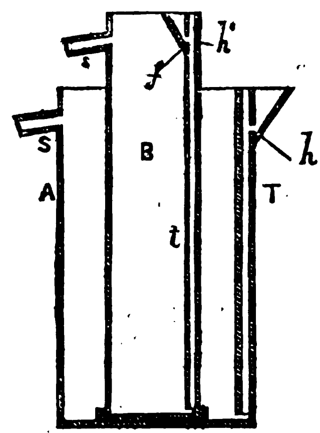


FIG. 2.

is well known, produces salts of that metal which are of but little, if any, commercial value, consequently these salts are regarded entirely as waste products, and are thrown away when the battery is cleaned out. The action of an ordinary battery is, therefore, not such as to produce a product, as far as the consumption of the zinc is concerned, which will repay its consumption irrespective of the electricity generated; nor are the other products produced in the battery of a comparative commercial value. If, however, instead of zinc, some metal be employed, the consumption of which will produce salts of a value greatly exceeding that of

the metal and acid consumed, then it must be evident that such an arrangement will be highly advantageous, as not only is there a profit to be made from the sale of the salt, but we have electricity produced, which is also a saleable commodity. Mr. Thomas Slater has had these facts in view amongst others in inventing an improved form of battery. His invention consists in employing a nickel electrode in the place of the usual zinc plate, and in forming the cells of which the battery is composed in such a manner that the liquids can be kept constantly in motion, and polarisation thus be prevented. The form of cell adopted is shown in plan and section by figs. 1 and 2 respectively. A is a glazed porcelain jar provided with a small spout, S, at its upper part. A tube, T, formed on the vessel, reaches from the top of the latter to within about half an inch of the bottom. At the top of the tube a funnel-shaped projection, E, is formed which communicates with the tube by a hole *h*. If liquid be poured into the funnel F, it passes down the tube T, and filling the vessel, overflows through the spout S, thus a continual circulation of the liquid can be kept up.

B is a porous chamber constructed in a similar manner to the outer vessel, viz., having a spout, *s*, a tube, *t*, and a funnel, *f*, with a hole, *h'*, communicating with the tube. This porous chamber is kept in the centre of the outer chamber by a recess in the bottom of the latter. The circulation of the liquids in the cells is easily kept up by a pump worked by a small electric motor.

The arrangement of electrodes and liquids in the battery may be various, but a very good plan is to employ carbon negative electrodes in the outer cell immersed in the ordinary bichromate of potash solution, and the nickel positive electrode placed in the inner cell in a solution of sulphuric acid or sulphuric acid and sulphate of ammonia. In the one case a single salt of nickel becomes formed, and in the other case a double salt. The presence of bichromate of potash in the cell in no way interferes with the formation of the salt, that is to say, it does not combine with it, but the nickel salt will crystallise out by itself and can be collected pure without difficulty.

The single salt, that is to say, the sulphate of nickel, which is formed in the battery, is proved by analysis to have the following composition :—

Nickel	20·99 parts.
Sulphuric Acid	34·16 „
Water	44·80 „
Waste	·05 „
	100·00

This agrees very closely with theory, according to which the amount of nickel should be 20·71.

When the fluids in the battery are such as to cause the double salt to be formed, then the latter is found to have the following composition :—

Nickel	14·91 parts.
Sulphuric Acid	24·30 „
Sulphate of Ammonia ...	33·42 „
Water	27·34 „
Waste	·03 „
	100·00

According to theory the amount of nickel should be 14·72.

The principal use of the nickel salts is for electroplating purposes, and great quantities are consumed for the purpose. Both the single and double salt of nickel referred to answers well for electroplating, but a solution, which Mr. Slater considers superior to the foregoing for plating purposes, may be obtained by charging the battery with a solution of common salt, this causes a double salt of chloride of nickel and sodium to be formed. The power of the battery when bichromate of potash is used as the negative excitant, and sulphuric or nitric acid, or sulphuric acid and sulphate of ammonia as the positive excitant, is about equal to a Bunsen. We have only to add that the commercial value of nickel is about 4s. per lb., and of the salts of nickel referred to, 3s. 6d. per lb. (these are quoted prices from the manufacturer), and the commercial value of the arrangement is obvious; for, taking the analysis given of the single salt of nickel, we have roughly—

21 lbs. of Nickel, at 4s. per lb.	£4	4	0
34 „ Sulphuric Acid, at 1½d. per lb.	0	4	3
45 „ Water	0	0	0
100	£4	8	3

There is thus produced 100 lbs. of sulphate of nickel, which, at 3s. 6d. per lb., gives £17 10s., besides the electric power generated. From this estimate, of course, deductions must be made for cost of plant, labour, waste, &c.; but, allowing for this, Mr. Slater's invention seems likely to be a highly profitable one when used for electric lighting, for motive power, or for plating purposes, &c., even supposing (as would be the case) the commercial value of the products decreased considerably.

This battery is to be seen at work at No. 97, Cheapside.

GRAMME'S ALTERNATING CURRENT DYNAMO-ELECTRIC MACHINE.

THE employment of alternating currents for producing the electric light is now very general, and the production of these currents has hitherto been almost invariably attained by means of two dynamo machines working quite independently; the one machine called the "excitor," producing continuous currents which excite the inducing electro-magnets of the second machine, from which the alternate currents are generated. M. Gramme has devised a form of alternating current apparatus in which both the excitor and generator are driven on one axle, thus forming a very compact and highly efficient arrangement. The new form of machine is shown by the figs.—fig. 1 being a sectional front elevation of the whole apparatus; fig. 2, a sectional elevation of the excitor coils; and fig. 3 a similar view of the generator coils. The position of the collecting "brushes" is shown in figs. 2 and 3.

The action of the excitor is to produce a continuous current as in the ordinary Gramme machine. This current passes through the revolving bobbins of the generator, thereby inducing alternate permanent polarity in their poles; the coils in front of these revolving alternate poles have alternate

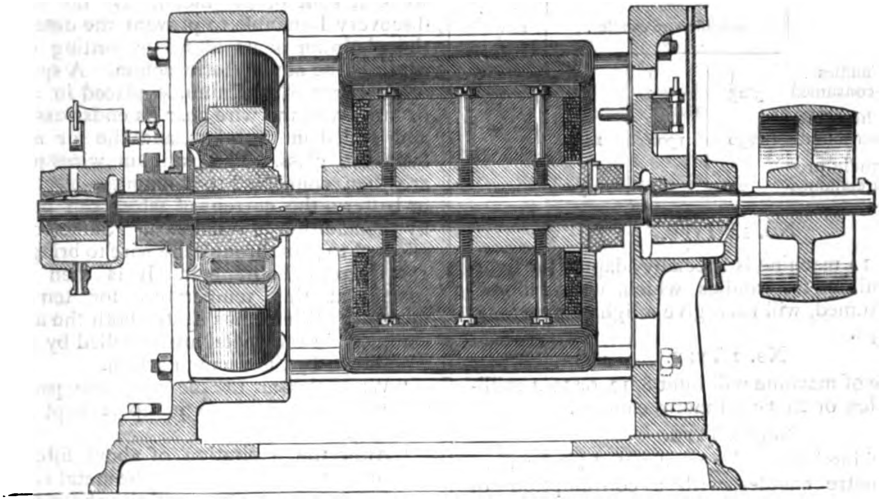


FIG. 1.

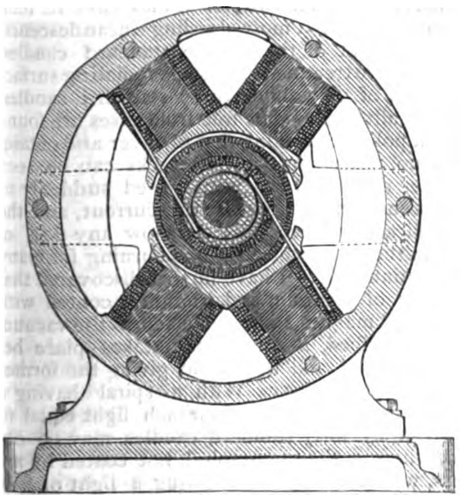


FIG. 2.

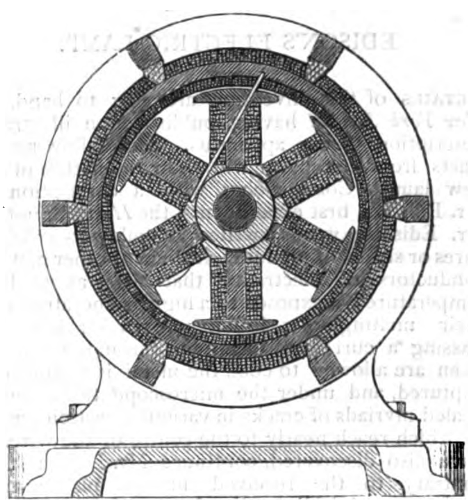


FIG. 3.

currents induced in them which pass out to the lamps.

Four types of the machine are at present manufactured, viz.:

No. 1 TYPE.

	4-millimetre candles.			3-millimetre candles.
Number of Candles ...	4	6	8	12
Horse power consumed	3·25	4·5	6	—
Speed of Machine in revolutions per minute	1250	1300	1450	{ 1460 to 1500
Light per candle produced, in Carcel lamps	70	60	50	30

No. 1A TYPE.

The No. 1A machine is specially adapted for lighting 12 3-millimetre candles, which, with 4 horse-power consumed, will each give a light equal to 30 Carcel lamps.

No. 2 TYPE.

This type of machine will light 8, 12, or 16 4-millimetre candles, or 24 3-millimetre candles.

No. 2A TYPE.

This machine is specially constructed for burning 24 3-millimetre candles with a consumption of 8 horse-power.

The cost of the candles with 3-millimetre carbons is 4d. The circuits of No. 1 machine, when it is required for burning 4, 6, or 8 lights, are grouped for quantity, as this gives the best effect. If the 12 lights are used then the circuits are joined up in series. In the case of 8 large or 12 small lights a resistance is introduced between the two parts of the machine.

EDISON'S ELECTRIC LAMP.

DETAILS of this invention are now to hand, the *New York Herald* having published an illustrated description of the apparatus. The following extracts from that paper will show the nature of the new lamp. Commencing with a description of Mr. Edison's first experiments, the *Herald*, quoting Mr. Edison's words, writes as follows:—"When wires or sheets of platinum, iridium or other metallic conductors of electricity that fuse at a high temperature are exposed to a high temperature near their melting-point in air for several hours by passing a current of electricity through them and then are allowed to cool, the metal is found to be ruptured, and under the microscope there are revealed myriads of cracks in various directions, many of which reach nearly to the centre of the wire. I have also discovered, continues Mr. Edison, that, contrary to the received notion, platinum or platinum and iridium alloy loses weight when exposed to the heat of a candle; that even heated air causes it to lose weight; that the loss is so great that a hydrogen flame is tinged green. After a time the metal falls to pieces; hence wire or sheets of platinum or platinum and iridium alloy as now known in commerce are useless for giving light by incandescence—

"1st. Because the loss of weight makes it expensive and unreliable, and causes the burner to be rapidly destroyed.

"2nd. Because its electrical resistance changes by loss in weight, and its light-giving power for the total surface is greatly reduced by the cracks or ruptures.

"The melting-point also is determined by the weakest spot of the metal. By my invention or discovery I am able to prevent the deterioration of the platinum or its alloys by cutting off or intercepting the atmospheric action. A spiral wire, or other forms of platinum, is placed in a glass tube or bulb, with the wire near its ends passing through and sealed in the glass, and the air is exhausted from the glass. The platinum wires of the spiral are then connected to a magneto-electric machine or battery, the current of which can be controlled by the addition of resistance. Sufficient current is allowed to pass through the wire to bring it to about 150 degrees Fahrenheit. It is then allowed to remain at this temperature for ten or fifteen minutes. While thus heated both the air and gases confined in the metal are expelled by the heat or withdrawn by the vacuum action.

"While this air or the gases are passing out of the metal the mercury pump is kept continually working.

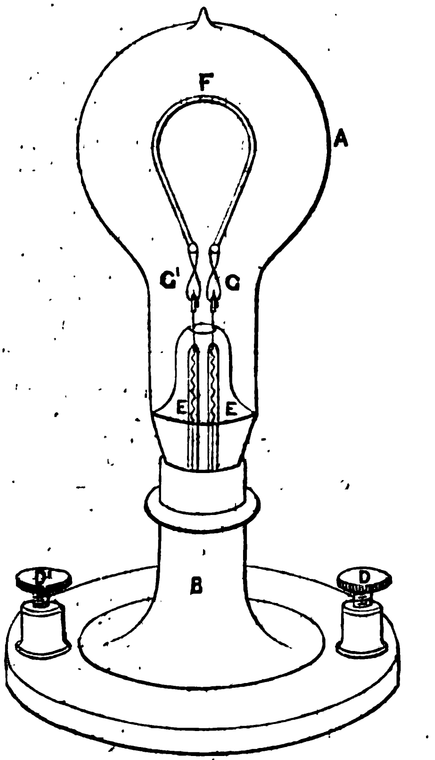
"After the expiration of about fifteen minutes the current passing through the metal is augmented so that its temperature will be about 300 degrees Fahrenheit, and it is allowed to remain at this temperature for another ten or fifteen minutes.

"The mercury pump is to be worked continuously and the temperature of the spiral raised at intervals of ten or fifteen minutes until it attains vivid incandescence and the glass is contracted where it has passed to the pump and melted together.

"The wire is now in a perfect vacuum and in a state heretofore unknown, for it may have its temperature raised to a most dazzling incandescence, emitting a light of twenty-five standard candles, whereas before treatment the same radiating surface gave a light of only about three standard candles. The wires after being thus free from gases are found to have a polish exceeding that of silver and obtainable by no other means. No cracks can be seen even after the spiral has been raised suddenly to incandescence many times by the current, and the most delicate balance fails to show any loss of weight in the wire, even after it is burning for many hours continuously. I have further discovered that if an alloy of platinum and iridium is coated with the oxide of magnesia and subjected to the vacuum process described, a combination takes place between the metal and the oxide, giving the former remarkable properties. With a spiral having a radiating surface of 3-16 of an inch light equal to that given by forty standard candles may be obtained, whereas the same spiral, not coated by my process, would melt before giving a light of four candles. The effect of the oxide of magnesia is to harden the wire to a surprising extent and render it more refractory. A spiral made of this wire is elastic and springy when at high incandescence. I have found that chemically pure iron and nickel drawn in wires and subjected to the vacuum process may be made to give a light equalling that of platinum in the open air. Carbon sticks also may be freed from air in this manner, and be brought to a temperature where the carbon becomes pasty, and on cooling it is homogeneous and hard."

About this time another truth dawned upon the inventor, namely, that economy in the production of light from incandescence demanded that the incandescent substance should offer a very great resistance to the passage of the electric current. Concerning this the inventor writes:—"It is essential to reverse the present practice of having lamps of but one or two ohms (electrical units) resistance, and to construct lamps which when giving their proper light shall have at least two hundred ohms resistance."

Having perfected the platinum lamp apparently, Mr. Edison was lead to try, "by accident," a filament of compressed lampblack and tar, heated by the passage of the electric current, and the result was



satisfactory. A piece of carbonised cotton was next tried, with better results still: a light equal to several gas-jets being obtained. Several other experiments with various carbonised substances were then tried, and finally the carbonised strip of cardboard was found to give the best results.

"With a suitable punch there is cut from a piece of 'Bristol' cardboard a strip of the same in the form of a miniature horse-shoe, about two inches in length and one-eighth of an inch in width. A number of these strips are laid flatwise in a wrought iron mould about the size of the hand, and separated from each other by tissue paper. The mould is then covered and placed in an oven, where it is gradually raised to a temperature of about six hundred degrees Fahrenheit. This allows the volatile portions of the paper to pass away. The mould is then placed in a furnace and heated almost to a white heat, and then removed and allowed to cool gradually. On opening the mould the charred remains of the little horseshoe cardboard are found. It must be taken out with the greatest care, else it will fall to pieces. After being removed from the mould it is placed in a little globe and attached to the wires leading to the generating machine. The globe is then connected with an air pump, and the latter is at once set to work extracting the air. After the air has been extracted the globe is sealed, and the lamp is ready for use. The fig. shows the lamp complete.

"A is a glass globe, from which the air has been abstracted, resting on a stand, B. F is the little carbon filament connected by fine platinum wires, G G¹, to the wires, E E¹, leading to the screw posts, D D¹, and thence to the generating machine. The current, entering at D, passes up the wire E to the platinum clamp, G; thence through the carbon filament F to G¹, down the wire E¹ to the screw post D¹; thence to the generating machine. It will be noticed, that the lamp has no complex regulating apparatus, such as characterised the inventor's earlier labours. All the work he did in regulators was practically wasted, for he has lately realised that they were not at all necessary—no more so than a fifth wheel is to a coach.

"He finds that the electricity can be regulated with entire reliability at the central station, just as the pressure of gas is now regulated. By his system of connecting the wires the extinguishment of certain of the burners affects the others no more than the extinguishment of the same number of gas burners affects those drawing the supply from the same mains. The simplicity of the completed lamp seems certainly to have arrived at the highest point, and Edison asserts that it is scarcely possible to simplify it more. The entire cost of constructing them is not more than twenty-five cents.

"The lamp shown in the fig. is a table lamp. For chandeliers it would consist of only the vacuum globe and the carbon filament attached to the chandelier, and connected to the wires leading to the generating machine in a central station perhaps a half-mile away, the wires being run through the gas pipes, so that in reality the only change necessary to turn a gas-jet into an electric lamp is to run the wires through the gas pipe, take off the jet, and screw the electric lamp in the latter's place. Although the plans have been fully consummated for general illumination, the outline of the probable system to be adopted is the locating of a central station in large cities in such a manner that each station will supply an area of about one-third of a mile. In each station there will be, it is contemplated, one or two engines of immense power, which will drive several generating machines, each generating machine supplying about fifty lamps.

"The apparatus for measuring the amount of electricity used by each householder is a simple contrivance consisting of an electrolytic cell and a small coil of wire, appropriately arranged in a box, the latter being of about half the size of an ordinary gas meter, and like a gas meter it can be placed in any part of the house. The measurement is obtained by the deposit of copper particles on a little plate in the electrolytic cell, such deposit being caused by the electric current passing through the cell. At the end of any period, say one month, the plate is

taken by the inspector to the central office, where the copper deposit is weighed, and the amount of electricity consumed determined by a simple calculation."

The Comte du Moncel has addressed a letter on the subject of Mr. Edison's invention to Dr. Cornelius Herz which was published in *Le Temps*. The Comte expresses astonishment at the excitement caused in the money market by the praises bestowed on the lamp, which is called, "A great discovery." "Edison," says the writer, "is an ingenious and fertile inventor, but is not acquainted with the discoveries made before his time. Neither the idea of the telephone nor the realisation of the phonograph belongs to Edison. His first lamp was a modification of the one invented by Changy in 1858. The one now announced is the modification of those of several inventors. In 1875 much noise was made about the incandescent carbon lamp of Korloff, the pretension being that one Alliance machine could feed fifteen lamps, and yet no more than two have ever been seen working. Regnier and Werdermann, by adding the voltaic arc to that combination, obtained better results. The new Edison lamp revives the Lodiguyne lamp in a different shape. The small carbon needles are replaced by laminated carbon, or carbonised Bristol paper separated by metallic tissues carved into the form of a horse-shoe, and joined to the circuit by platinum wires, the whole being in a vacuum, as in Lodiguyne's system. That arrangement may be better than anything previously devised, but it is not an invention of the importance assigned to it by the American papers. The idea of intercalating metallic bodies in the carbonised mass is not new, for it had been realised by Jablochkoff and Kelmer. It is difficult for the carbon horse-shoe, so loose and delicate, not to be deteriorated by prolonged incandescence, on account of the caloric action disintegrating the carbonic particles and by the mechanical action of the current which carries them away and deposits them on the sides of the recipient, as in Geissler's tubes. The metallic tissues separating the layers of carbon would be damaged. Experience alone will be able to decide, and it is prudent to wait, in spite of the announcement of fifty or sixty foci fed from a single machine. The same may be said of the dynamo-electric machine which offers nothing new about which the theories put forth would upset the laws of Ohm and Joule, theories which are at variance with the experiments made with every other machine. Edison has given no account of the maximum effects." The writer finally protests against the *sans façon* of the Americans with regard to European inventions. "For them electrical science, which sprang up yesterday, was discovered in America. Many examples might be cited, to which the name of Mr. Prescott is not foreign, but we prefer to say no more. Let the public be on their guard against the pompous announcements which reach us from the New World."

ERRATUM.—At the end of the article on the "Brush" Electric Light system, which appeared in our last issue, "2,000" candles were, by a printer's error, given as "20,000."

THE ELECTRIC LIGHT AT LUDGATE HILL.

THE premises of Messrs. Samuel Brothers, Merchant Tailors, of Ludgate Hill, London, have been fitted up with the electric light, and the inauguration of the lighting took place on Wednesday evening, the 14th inst., in the presence of a large number of gentlemen interested in the question of electric lighting, representatives of the press, &c., &c.

They are lighted by means of thirteen electric lamps of the Jablochkoff system, and which are distributed as follows :—

One in each of the two windows on each side of the principal entrance in Ludgate Hill; two in the front of the ground floor; two in the back of the ground floor; one in the counting-house; one over the landing of the large staircase leading to the upper floor; three in the juvenile and ladies' department on the first floor; two in the gentlemen's bespoke department on the first floor.

The lamps are all suspended from the ceiling, at a distance of about eight feet from the floor, and by means of harp pendants, through which the conducting wires are conveyed to the candles. They are made to contain four Jablochkoff candles, and as each candle lasts two hours, a continuous light for eight hours is therefore provided. The lamps can easily be replenished when the last candle is burning, so that, practically speaking, the light can be made to be continuous for any length of time.

The globes are of the opalescent description and are 20 inches in diameter.

The currents of electricity are produced by a battery of Gramme Patent Dynamo Electric Machines of the 20-light size; the battery being composed, as is well known now, of a small Gramme continuous current machine exciting a large alternating current distributing machine. The large machine is divided into four circuits, capable of maintaining five lights each. In the existing arrangement three circuits only of the distributing machine are utilised, two maintaining four lights each, and one maintaining five lights.

An additional lamp was temporarily added to that number, and was kept burning in the engine-room, which it lighted admirably.

The lights are arranged so as to be all switched from a switch board placed at one of the cashier's desks on the ground floor. This arrangement is an important feature, and the switching was shown in operation.

The motive power for working the electric machines is obtained from a 12 horse-power "Otto" gas engine, made by Messrs. Crossley Brothers, of Queen Victoria Street, London.

It is within the mark to say that this form of engine is taking the place of steam at the rate of twenty-five engines a week, a fact that should go a long way to re-assure holders of gas-stock.

The Gramme machines are driven directly by means of suitable pulleys fixed on the shaft of the engine, the small one, or excitor, running at a speed of 612 revolutions, and the large one, or distributor, at a speed of 688 revolutions per minute. They are together with the gas engine erected in a room situated in the basement at the back of the building.

The whole mechanical and electric plant, which has been fitted up under the immediate super-

vision of M. J. A. Berly, C.E., the Engineer to the Société Générale d'Electricité, is erected in a most substantial manner.

At an experiment made by M. Berly, and Mr. Wilson, C.E., the London representative of the firm of Messrs. Crossley Brothers, twenty lights were maintained by the gas engine, and there is no doubt that a larger number could be maintained after the plant has been in operation during a certain period, as the stiffness with which all new machines work will gradually disappear and the producing qualities of the Gramme machines will gradually improve.

This is the first time, in this country as well as in France, that a large number of Jablochkoff lights have been worked from a gas engine, and Messrs. Samuel Brothers deserve great credit for the enterprising spirit which they have shown, in adopting for their splendid establishment this mode of illumination which is now steadily making its way ahead, and will, in all probability, be generally adopted within a very limited period.

On visiting the bespoke and ladies' department of Messrs. Samuel Brothers' premises, we could at once appreciate the immense advantage that the purchasing public would derive from the introduction of the electric light.

On examination of some ladies' costume cloths, gentlemen's suitings, &c., we found that the most delicate colourings and tints were as distinctly discernible as if viewed by daylight.

Correspondence.

TRIALS OF THE JABLOCHKOFF AND WERDERMANN ELECTRIC LIGHTS IN PARIS.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—In your issue of the 15th ultimo you publish an extract from the French newspaper *L'Estafette*, in which some particulars of the competitive trial of the Jablochkoff and Werdermann lights at the "Foyer de l'Opera" are given.

As many of the statements published by *L'Estafette* are erroneous, I shall feel very much obliged if you would kindly publish the enclosed letter, which was addressed by the chairman of the Soc. Gen. d'Electricité to the journal *L'Estafette*, and published by the latter in its issue of the 28th November, 1879.

Yours faithfully,
J. A. BERLY, C.E.,
Engineer to the Soc. Gen. d'Electricité.

Extract from the Journal *L'Estafette*, November 28, 1879.

"We have received the following letter:—

"To the Editor of *L'Estafette*.

"Sir,—We have read in your issue for November 22nd an article on some experiments made yesterday at the *foyer* of the Opera House, an article which contains such serious errors that we are compelled to reply to it.

"If the editor of the article in question had really attended the experiments of which he writes he would not have seen in the room MM. Turguet, Herold, and Alphand, who were *not* present at the experiments, and he would have seen that the *two chandeliers supplied with gas by the Parisian Company* were not lighted.

"We had no wish to point out that the experiments of the Werdermann Society had been favoured by the obliging co-operation which our Society had offered, in putting at their disposal its motor and its workmen. We ask simply in exchange for impartiality.

"The text of the article obliges us to relate the facts of the case.

"It is said that '*the Jablochkoff lamps made their appearance before those of Werdermann, because the Jablochkoff Company delayed in getting ready the steam engine which should have been lent to the Werdermann Company.*'

"This fact is erroneous; the engine in question had been since the 22nd October at the entire disposal of M. Napoli, engineer-in-chief to the Werdermann Company. In spite of this the experiments had to be made at two different times as the Werdermann apparatus was not ready.

"The globes of yellow glass were only placed upon a formal demand being made; they proved, in every case, capable of giving the required tint to the light. In spite of the reduction which they produced upon the eight Jablochkoff lights, the total light produced was incontestably superior to that of the twelve Werdermann lights.

"The hissing noise, who heard it?

"As to the power absorbed by the twelve Werdermann lights, we can say what this was better than any one, inasmuch as we lent the engine which produced the light. This engine was driven at such a high velocity and at such a pressure of steam that the funnel became red-hot along a great portion of its length, necessitating important repairs. The Jablochkoff lamps, driven by the machine which serves ordinarily for the lights placed on the Place de l'Opéra, consumed 8 horse-power, and gave a total intensity superior to that of the twelve Werdermann lamps, which absorbed, thanks to the manner in which the motor had been driven, as much power, if not more.

"As to the differences of velocity of the Gramme machines, they existed in effect, but in the reverse sense to that attributed.

"As to the respective qualities of the two lights, it would appear useless to refer to them. We leave this for the public to judge.

"Trusting that you will have the kindness to allow these corrections to appear in your columns,

"We remain, Sir, etc.,
"A. DE SOURDEVAL,
"President of the Council."

ADELAIDE, S.A.—Lines running east and west are rather more subject to earth current disturbances than those running north and south, but no inconvenience worth speaking of arises from this fact. In England, at least, no difficulty whatever is found in working lines running east and west as compared with those running north and south.—ED. TEL. JOUR.

IT is stated that the German Postmaster-General is preparing a proposal to be presented to the Reichstag, under which the post-office department will have charge of the entire freight traffic of the German railways, and will become the general carrier for the German public.

Notes.

EDISON'S NEW ELECTRIC LAMP.—A strip of cardboard bent into a horse-shoe form and converted into carbon by baking in an iron mould, is the basis of the new lamp; the strip is placed in an exhausted globe, and a current of electricity being sent through the strip renders the latter incandescent. As regards durability, &c., the *Times* correspondent says:—"About 60 lights were burning. On Saturday night I saw them burn seven hours. Two have been burning continuously for ten days without injury to the baked cardboard horse-shoe in the little glass globe which furnishes the light. Cardboard seems sufficiently durable, successfully resisting quite rough usage, such as dropping, shaking, turning the current on and off thousands of times, and raising the intensity of light to that of 400 candles. All the arrangements are simple. Mr. Edison will put about 800 lights at Menlo Park, while the inventions immediately go into practical operation in New York city. The globe containing the horse-shoe is exhausted to one-millionth of an atmosphere by the Sprengel pump, measured by the M'Leod gauge. By successfully dividing the electric current Mr. Edison gets individual lamps of 16-candle power, each lamp having 100 ohms resistance. Light is turned on or off and the current regulated with the same ease as gas is, while the current can be transmitted on wire as small as No. 36. The central regulator maintains an even current, while the meters accurately measure the supply furnished to each consumer. Mr. Edison finds that the best generators are of five to seven horse-power, each one horse-power maintaining eight lamps. Each lamp costs about one shilling to manufacture, while a supply equivalent to 10,000ft. of gas can be produced for tenpence or less. Mr. Edison calculates the cost of furnishing light thus—the consumption of 3lb. of coal in a steam engine will maintain eight to ten lamps one hour. Mr. Edison's system also furnishes electric power for small industries, such as running sewing machines. Mr. Edison's light is bright, clear, mellow, regular, free from flickering or pulsations, while the observer gets more satisfaction from it than from gas. Mr. Edison lights at Menlo Park, dwellings, offices, desks, street lamps, also laboratory and workshop, making it available for every lighting purpose for which gas is used."

THE telegram which announced Mr. Edison's invention created great excitement, and we think it a matter for regret that such an influential journal as the *Times* should publish such sensational announcements, which, although they will be taken for what they are worth by all scientific men, yet tend to mislead the general public. We may mention that Mr. J. W. Swan, writing to *Nature*, says, "Fifteen years ago I used charred paper and card in the construction of an electric lamp on the incandescent principle. I used it, too, of the shape of a horse-shoe, precisely as, you say, Mr. Edison is now using it. I did not then succeed in obtaining the durability which I was in search of, but I have since made many experiments on the subject, and within the last six months I have, I believe, completely conquered the difficulty which led to previous failure, and I am now able to produce a perfectly durable electric lamp by means of incandescent carbon."

Apropos of Mr. Edison's so-called discovery, we commend to the notice of our readers an excellent article on "The Great Edison Scare," which appeared in the number of the *Saturday Review* for Jan. 10th.

IN the last presidential address to the Royal Society, Mr. Spottiswoode mentioned, that "The electric light has been recently effectively employed in surveying and sounding the Mediterranean by night, and in the operation of laying and repairing cables by the s.s. *Dacia*, belonging to the Silvertown company. By its aid 96 soundings, made with Sir William Thomson's steel wire apparatus, in water averaging 1,500 fathoms depth, were taken in seven days and nights, bottom in every case being brought up."

ELECTROLYTIC EXPERIMENTS.—Some remarkable electrolytic experiments have recently been made by Herr Dreschsel. Instead of employing a continuous current to effect decompositions, Herr Dreschsel submits the substance under test to a series of rapidly reversed currents. The first experiment was made with a solution of carbonate of ammonia, using platina electrodes. After about eight hours' duration of the experiment, the liquid was evaporated in the water-bath, and a salt crystallised out, in beautiful white needles. This proved to be a salt of a platinum base. As a controlling experiment, a solution of the ammonia salt referred to was afterwards submitted to the ordinary kind of electrolysis; and it was found that the liquid then contained no dissolved platina. It appeared that with a slow reversal of the current no precipitate was separated, unless the liquid be simultaneously cooled; under these circumstances there is an abundant crystalline precipitate, which likewise presents a salt of a platina base, but contains less platina than the first-described combination. When a grape-sugar solution, with phosphate of soda added, was electrolysed by means of very large platina electrodes, which were kept from contact by means of a disc of blotting-paper, the platina was found, at the end of the experiment, in the places where the paper was applied, covered with a brownish, transparent coat, easily removed in large lamellæ, which, on combustion, left behind considerable quantities of platina.

THE SCOTTISH TELEPHONIC EXCHANGE.—A Telephonic Exchange has been formed in Scotland having centres at Edinburgh, Glasgow, and Dundee. The Company will place in the office, warehouse, or residence of each member the requisite instruments and appliances, connecting the same by means of a wire with the central office, and maintaining them in working order at a rental varying from £10 to £20 per annum, according to the facilities required. Mr. J. G. Lorrain, C.E., is the general manager of the Company.

BRAZILIAN TELEGRAPHS.—"The Government lines in Brazil work in a very efficient manner; since the 1st of January there have been only 28 interruptions, principally short ones, the longest having lasted but 3 days. The same good fortune has not attended the Western and Brazilian Company's coast cable, which has, during the same period, been subjected to 4 interruptions, extending over an interval of 93 days, the shortest stoppage having lasted 7 days. The Government land lines forwarded all the messages which were refused by the Cable Company owing to the suspension of their traffic. The Government tariff for a message from Recife to Rio Janeiro is one franc, whilst the Cable Company charge five francs. From Recife to all points of the empire south of Rio Janeiro the Government charge is two francs per word."

AUSTRIAN TELEGRAPHS.—According to the report issued by the Ministry of Trade the present system of telegraphs in Austria consists of 23,069 miles of line, containing 58,919 miles of wire. This quantity includes 15,140 miles Government line, 7,650 miles railway lines, and 277 miles of private lines. There are 2,484 stations, of which 1,088 are Government,

1,301 railway, and 95 private. In the Government offices 1,772 Morse, 52 Hughes, 5 Meyer's multiplex instruments, and one d'Arlincourt translator are in use. The total number of messages despatched was 5,087,568, the inland messages amounting to 3,563,294, the total showing an increase of 2·7 per cent. over the preceding year.

NOTICE has been given in the *Canada Gazette* that application will be made at the next session of the Parliament of the Dominion of Canada for an act to "incorporate the French Atlantic Cable Company," and to create the Compagnie Française du Télégraphe de Paris of New York, and create the shareholders in said company a corporation within the Dominion of Canada under the name of "The French Atlantic Cable Company."

THE NEW ZEALAND TELEGRAPH DEPARTMENT.—The fifteenth annual report of the New Zealand Telegraph Department states that the revenue for the year ending 30th June, 1879, was estimated at £76,000, but it has exceeded that amount by £5,435 14s. 4d. Omitting the value of Government telegrams, which amounts to £26,926 13s. 7d., the gross earnings of the department, including subsidies for special wires, incidental receipts, and sundry recoveries show the total receipts for the year to have been £85,402 0s. 2d. Adding to this the value of Government messages, the total value of business performed by the department amounts to £112,328 13s. 9d. The total number of messages of all codes transmitted during the year was 1,448,943, being an increase over the previous year of 188,619, or nearly 14 per cent. The working expenses for the year amount to £96,801 8s. 3d., which, after taking credit for the Government messages, leaves a credit to the department of £15,527 5s. 6d., or 3·73 per cent. on the capital invested. The item for cost of maintenance of stations shows an increased expenditure of rather more than £10,000 over the previous year. This is to be accounted for by the constantly increasing work of the department and the opening of new stations. Comparing the number of telegrams transmitted during the year with the letters posted during the same period, the result shows that 19·64 telegrams were sent for every 100 letters. The proportion last year was 20·71. The number of money-order telegrams sent during the year was 14,607, representing a value of £61,693 9s., being an increase over the previous year in messages 1,807, and value £6,770 18s. 7d. The commission collected by the Post Office on these transactions amounts to £1,758 9s. 4d. From this amount has to be deducted the sum of £730 7s. as fees on telegrams, which leaves £1,028 2s. 4d. to the credit of the Post Office, which is equal to 1·666 per cent. upon the total amount transmitted. During the year 109 miles of line carrying 113 miles of wire have been erected, and 296 miles of wire erected on existing lines, making the total mileage in circuit on 30th June of line 3,543, and wire 8,444. The number of stations open to the public on the 30th June was 195. Of these 16 were opened during the past year, 11 being in the North Island and 5 in the South Island. The mileage of line maintained during the year was 3,434 miles, at an average cost for maintenance of £5 0s. 9d. per mile. The "Urgent Code" referred to in the last year's report continues to increase in public favour, and is very largely taken advantage of by the mercantile portion of the community. The number of "urgent" messages transmitted during the past year was 30,106, giving a value of £4,623 7s. 10d., being an increase over the past year of 16,651 messages, and value £2,523 11s. 2d. Since the date of the last report a "Delayed" code has been introduced, and is greatly appreciated by the public. The fee for these telegrams is one-half the ordinary fee, in addition to which a postage fee of one penny is charged. These telegrams are accepted at any time throughout the day, and are forwarded to their destination and posted the same evening after the close of business, so that they may be delivered by the first postal delivery the following morning. The system was introduced on the 1st of July, 1878, and since that date 56,721 "delayed" telegrams have been transmitted, yielding a revenue to the department of £2,846 9s. 2d.

INDIAN TELEGRAPH LAWS.—The powers and privileges of Government in calling for messages sent over the telegraph wires in India, says the *Madras Mail*, are probably not generally known. Section 5 of the Telegraph Act (Act No. 1 of 1876) runs as follows:—"On the occurrence of any public emergency, or in the interest of the public safety, the Governor General in Council, or the Local Government, may take temporary posession of any line of telegraph established or maintained by any company or person licensed under this Act, or may order that any message to or from any person, or relating to any specified subject, shall be intercepted or communicated to the Government or any officer thereof mentioned in such order. If any doubt arises as to the existence of a public emergency, or whether any act done under this section was in the interests of the public safety, a certificate signed by a Secretary to the Government of India or to the Local Government shall be conclusive evidence on the point." Section 17 of the Act provides that any telegraph officer who . . . "wilfully or otherwise than by the official order of a Secretary to the Government of India or the Local Government, or of such other officer as the Governor General in Council authorises to give such order, intercepts any message or any part thereof, or divulges any message, or the purport of any message or of any part thereof, to any person not entitled to receive the same . . . shall be liable to imprisonment for a term not exceeding three years, or to fine, or to both." Section 21 runs as follows: "Whoever transmits or causes to be transmitted by telegraph a message which he knows to be false or fabricated shall be liable to imprisonment for a term which may extend to three years, or to fine, or to both." The whole of the Telegraph Act is contained in twenty-three sections. We imagine that few people are aware of the extraordinary "powers and privileges" it confers on the Government in India. That such an act would be tolerated in any British community out of India seems highly improbable. It goes without saying that these powers and privileges were never intended to be exercised except under the most exceptional circumstances, such as danger to the State, &c.; but, as the Act stands, it is left to a local Government to determine what is a matter of "public emergency," and the Act, therefore, virtually authorises a fretful or meddlesome Government to pry into the history of almost any telegram that may be printed in a newspaper. It is just as well that both senders and receivers of telegrams should be aware of this fact, so that they may take precautions accordingly.

IN a letter to the *Colliery Guardian*, Mr. Ralph Loudon, of Wenworth Colliery, Newcastle-on-Tyne, says: "During the last few weeks the magnetic needles of our galvanometers have shown their sensitiveness to the electrical changes in our atmosphere. About a fortnight ago I was rather struck on observing the leaves of a gold-leaf electroscope promptly diverge, and suddenly collapse, owing to a discharge of atmospheric electricity in our latitude.

"Several times in succession the behaviour of the electroscope was magnificent, inasmuch as I sat up late

at night recording no less than 27 charges and discharges of the leaves. This prompted me to attach by a wire one binding screw of a galvanometer to the rail of a waggon-way, which has a length of about ten miles. The other binding screw of the galvanometer I connected to the gas pipes which pass through our villages. By this means I had an earth connection of about one hundred square miles. The circuit completed, I anxiously awaited results. Scarcely had I made the connection than the needle of the galvanometer quivered to the right and left of the zero point. Sometimes a deflection was caused having an angle of there degrees. But the majority of deflections were upwards of seven degrees. Afterwards I tried a shunt, but utterly failed to register accurately the amount of deflection. At every deflection of the galvanometer the surface of the earth had its electrical condition changed. The storms were, in the majority of cases, unheard, and seldom a flash of light was seen. The surveying dial, commonly used for mine surveying, though not so sensitive as the needles of our galvanometer, was occasionally disturbed, and rendered sensitive enough to be easily repelled by the near approach of a surveying lamp.

"Having the opportunity the other day to be standing beside a mining dial, in a mine having a depth of about 170 fathoms, I stood in amazement at seeing the *north end* of the needle *repelled* by a brass Clanny lamp, having a copper gauze. Certainly, we know that cabonic acid, hydrogen, oxygen, and nitrogen, repel the magnetic needles of our surveying instruments; but not such an amount of dia-magnetism is found in the above-named gases as to be taken into consideration. Copper showing the greater dia-magnetic properties over the gases no doubt accounts fully for the behaviour of the needle, as the latter must have been particularly sensitive to the electric state of the moving current. Such phenomena, though occurring at rare intervals, give rise to a series of questions, on which the best authorities seem not at all agreed. It would appear, from the action of the various magnetic needles under these most strange circumstances, that they are ever in search of a position of rest.

"Should the magnetic curve be travelling westward in our locality, and awaiting the earth's electrical equilibrium to be restored, no doubt, at these precise moments, a number of errors can be committed, even by the most skilful and practised surveyor. Or, suppose the magnetic curve be travelling eastward, the more glaring will be the error in long and delicate surveys. The direction of the earth's magnetism has a close relation to the earth's shape; but, as we know, it is not in any way the cause of this shape, we may suppose that the figure of the earth and the rotation which causes the earth to keep this figure have something to do with the production of magnetism. At present, there seems to be some influence at work which, along with the earth's rotation, results in magnetism. What is this influence? I venture to say, the sun. The most distinguishing features of it, are chiefly these four: 1. Its rifts and general radiating appearance. 2. The crossing and bending of rays. 3. Its self-luminosity, as spectroscopic observations have shown. 4. Its changing and flickering character. After a prolonged period of solar quiescence, the disc of the sun is beginning to assume new features, and will most assuredly cause magnetic storms. The late French mathematician, Leverrier, long since pointed out the absolute necessity of care, and warned surveyors against the hasty conclusions arrived at in their surveys. Under the present circumstances, long and delicate surveys ought to be deferred, if possible."

CASE OF LIGHTNING-STROKE.—A paper was read at a late meeting of the Clinical Society by Dr. G. Wilks, of Ashford, on a remarkable case of lightning-stroke, which occurred on June 8th, 1878. A farm labourer was struck by lightning while standing under a willow tree, close to the window of a shed in which his three fellow workmen had just taken shelter from a violent storm of rain. His companions found the tree partly denuded of its bark, and the patient's boots standing at its foot. The patient himself was lying on his back two yards off, and though he was fully clothed previously, he was now naked, with absolutely nothing on except part of the left arm of his flannel vest. He was conscious, but much burnt, and his leg was badly broken. The field around was strewn with fragments of the clothing; the clothes were split or torn from top to bottom, the edges of the fragments being often torn into shreds or fringes; they only showed evidences of fire where they came in contact with metal, such as his watch and the buckle of his waist-belt. There were no laces in the boots. The left boot was torn and twisted into fantastic shapes, but the sole was uninjured, and there was no signs of fire upon it; the right boot had the leather much torn and the sole rent and burnt. The watch had a hole burnt through the case, and the chain was almost entirely destroyed. The stockings were split down the inner side; the hat was uninjured. The patient stated that he was struck violently on the chest and shoulders, became enveloped in a blinding light, and was hurled into the air, coming down on his back "all of a crash," and never losing consciousness. The hair of his face was burnt, and the body was covered with burns. Down each thigh and leg was a broad crimson indurated band of burning, passing along the inner side of the knee, and ending below the left inner ankle and at the right heel; a lacerated wound, with a comminuted fracture of the os calcis. The bones of the right leg were fractured, and the tibia protruded through the skin in the course of the burn. He was discharged healed twenty weeks after the occurence. Dr. Wilks remarked on the almost complete exemption of the nervous system and on the probability that the clothes being wet acted as good conductors, and so diverted the electric current from the great nervous trunks, thus saving the man's life.

STEELING COPPER PLATES.—R. Bottger uses 100 parts of ammonio-ferrous sulphate, and 50 parts of ammonium chloride dissolved in 500 parts of pure water, a few drops of sulphuric acid being added; the liquid is maintained at 60° to 80°, and the copper plate is immersed in this liquid and made the cathode of a battery of 2 or 3 Bunsen cells, the anode being an iron plate equal in size to the cathode. In a few minutes a hard steel-like deposit of iron is formed on the copper plate.

INDIA-RUBBER TRADE AND MANUFACTURE.—In an interesting article in *The Journal of Applied Science* occurs the following: The average annual import of gutta-percha is only from 20,000 to 25,000 cwt., and has apparently reached its maximum quantity; while the supply of india-rubber continues steadily to increase. This is best shown by a comparison of the average quinquennial receipts of the two substances:—

Average of Five Years ending	India-rubber. Cwts.	Gutta-percha. Cwts.
1856	27,598	19,846
1861	33,864	19345
1866	67,989	23,957
1871	134,993	21,538
1876	151,194	21,577
1878	149,724	32,912

A tabular statement of india-rubber imported into

the United States in the years ending June 30th is also given, these imports being nearly all derived from Brazil.

Year.	Quantity.	Value in Dollars.
1868	8,438,000	2,180,336
1869	7,813,000	2,505,632
1870	9,624,000	3,459,665
1871	6,155,000	2,307,233
1872	11,803,000	4,789,590
1873	14,536,978	4,900,550
1874	14,191,320	6,196,729
1875	12,035,634	4,675,490
1876	10,589,297	4,063,659
1877	13,821,109	5,542,166
1878	12,512,203	4,711,108

NATURAL ELECTRO-PLATING.—Some specimens of minerals collected in South America by M. Fremier, who was for some time director of the silver mines at Caracoles, have been examined in Paris by M. Jannettaz, who has discovered among them an extraordinary example of an ammonite transformed into native silver. It was found with a number of other ammonites belonging to the two species *A. peramatus* and *A. plicatilis*, but these had not been mineralised with silver salts. The ammonite in question has, on the other hand, been entirely replaced by chloride of silver, which has been partially reduced to the metallic condition. Light is thrown by this specimen upon the origin of the native silver which occurs in the Caracoles mines, for it is only fair to infer that this metal has, in like manner, been reduced from the state of chloride at a period not earlier than the deposition of our Oxford clay. The description of the ammonite in silver will be found in a recent number of the *Bulletin* of the Geological Society of France.

FISH KILLED BY ELECTRICITY.—The *Nassauer Bote* states that during a very heavy thunder and hail storm at night time, a flash of lightning struck a small pond at Seck, in the Grand Duchy of Nassau, well stocked with various kinds of fish, the property of the pastor of the parish. The following morning the whole of the fish were discovered dead upon the surface of the water. They had all the appearance of having been half boiled, and crumbled to pieces at the least touch, just as is the case with fish after being boiled. Neither any external nor internal injury could be observed, the scales being intact and the swimming bladder filled and well preserved. The water in the pond was still muddy and dull the morning after the storm, as if the lightning had only then struck it.

THE TORPEDO EXPLOSION.—A few days ago an inquest on William Southey, able seaman, who died from injuries received from an explosion of countermines in Fareham Creek, was held at Gosport. Deceased was one of a countermining party sent out from her Majesty's ship *Vernon* for torpedo instruction, and when only three mines in one line had been stopped an explosion of all in the circuit took place. The charges in each consisted of three pounds of powder in a case. A piece of tin struck Southey on the head, inflicting a severe wound. Three of the men were injured. The evidence of Lieutenant Frank Henry Rogers, of the *Vernon*, who was out with the countermining party, went to show that while the mines were being laid, and before the flag was dropped, an explosion took place. On going on board the battery boat, in charge of Mr. Macdonald, gunner, he found the main wire joined to the positive pole of the battery, and that the firing key, which ought to have been on the positive pole of the battery, was on the negative pole. The return wire being disconnected, and held in a man's hand, and the main wire being joined up in that manner, was highly dangerous.

New Patents—1879.

5242. "An improvement in the manufacture of matrices for the production of electrotypes and stereotypes, and in type printing, whereby the operation of setting-up type may be dispensed with." G. D. MACDOUGALD. Dated Dec. 23.

5254. "Construction of posts or supports for railway signals and telegraph wires." J. S. WILLIAMS. Dated Dec. 23.

5270. "Improvements in apparatus for operating or adjusting and securing railway switches, crossings, and signals, or parts connected therewith." J. S. WILLIAMS. Dated Dec. 24.

5297. "Improvements applicable to signals used on railways." H. JOHNSON. Dated Dec. 27.

5319. "Improved telephonic exchange system and apparatus for effecting telphonic communication." E. DE PASS. (Communicated by the Law Telegraphic Company.) Dated Dec. 30.

5335. "Telephones." A. WHITE. (Communicated by T. A. EDISON.) Dated Dec. 31.

5337. "Improvements in automatic switches for telephones and other electrical apparatus." A. M. CLARK. (Communicated by E. T. Greenfield and D. McL. Adee.) Dated Dec. 31.

1880.

5. "Magnetic curative appliances." F. BAPTY. Dated Jan. 1.

18. "Electric lamps." J. W. SWAN. Dated Jan. 2.

33. "Improvements in apparatus for developing electric currents and regulating the action of the same, in circuits that pass to electric lights or electro-magnetic engines." T. A. EDISON. Dated Jan. 3.

75. "Improvements in dividing and apparatus for regulating the electric light." A. M. CLARK. (Communicated by L. Roguier.) Dated Jan. 7.

79. "Improvements in apparatus for producing and utilising electric currents, and in lamps to be employed in connection with the same or similar apparatus." R. WERDERMANN. Dated Jan. 8.

91. "Microphonic and telephonic apparatus." W. R. LAKE. (Communicated by E. Berliner.) Dated Jan. 8.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

1959. "Improvements in electric lamps." JOHN HOPKINSON. Dated May 6. 4d. This relates to that class of electric lamp in which the arc is used, and in which the current passing is maintained constant by means of an electro-magnet, through which the current passes on its way to the electric arc. Points of the main circuit are connected on opposite sides of the electric arc by a fine wire, forming a solenoid or electro-magnet. The current in this fine wire is proportional to the difference of electric potential on the two sides of the lamps. When the carbons are so far parted that this difference is greater than the proper amount, the solenoid or electro-magnet of fine wire actuates a connection, whereby the electro-magnet of the lamp itself is short-circuited, and is caused to permit the carbons to approach. The result of this arrangement is that the lamp maintains the differenee of electric potential on the two sides of the arc constant, instead of maintaining the quantity of the current constant.

1994. "Electric bell apparatus." H. J. KIRBY BOUCHETTE and JOSEPH ALDRIDGE. Dated May 20. 2d. This combines bells and pushes in one block, so that persons may communicate between various rooms and places, and so that the person to whom the signal is sent may also send signals himself either to one or a number of rooms. (*Not proceeded with.*)

2000. "Electric lamps." JOSEPH COUGNET. Dated May 20. 2d. The action of the lamp is as follows:—The two poles or carbons being nearly in contact one with the other, a suitable electric current is caused to pass through an electro-magnet and to the positive pole, from which it passes to the negative pole. As long as the said carbon is in a condition to produce the electric light, a lever or armature is attracted to the electro-magnet, and resists the action of a weight which tends to raise the said carbon; but as soon as a sufficient portion of the carbon is consumed, the electric current passes with less intensity, and the lever or armature is set nearly free, and allows of the positive carbon being raised to the required extent, when the lever or armature is again attracted to the electro-magnet, and causes the feed of the carbon to cease. (*Not proceeded with.*)

3577. "Signals for telephone and telegraph lines." WILLIAM THOMAS WHITEMAN. (A communication from abroad by Samuel Ward Francis of Newport, Rhode Island, U.S.A.) Dated September 5. 6d. Are designed so that any one station can call the central station, or be called, without disturbing the others.

City Notes.

Old Broad Street, Jan. 13th, 1880.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.—The seventh ordinary general meeting of this company was held January 8th, at the City Terminus Hotel, Sir EDWARD WATKIN, M.P., presiding. The report of the directors, which was taken as read, stated that the receipts for the past year were £92,733, showing a decrease of £148 as compared with the previous year. Under their agreement with the Brazilian Submarine Company, the latter have raised the question whether, owing to the long and repeated interruptions to the traffic, the Western Company were entitled to share in the revenue of that company during the continuance of such interruption. This was compromised by their consenting to deductions amounting to £7,069, but for which, and others of smaller amount, the revenue would have reached a sum of £106,882. The expenses on general account was £27,615, against £31,297 last year. The measures taken for repairs with sheathed cable in shallow water had resulted in a great improvement, but there was more work to be done in the same direction. The cost of maintenance and renewals in 1877-78 was £69,194, but in 1878-79 the outlay was £72,104. The directors proposed to charge direct to revenue £24,270, under the head of maintenance, and to carry the balance of revenue, amounting to £19,926, to renewal account. This, with the balance standing to the credit of that account, and the balance of revenue from last year of £3,263, making together £43,866, would leave a small balance of £3,967 to carry forward as a debt to the renewal account of the current year. The receipts for the first ten weeks of the current quarter averaged £2,900 per week, showing, after certain payments, a yearly revenue of £126,490 to the company.—In moving the adoption of the report, the CHAIRMAN said that, briefly summarised, it showed a net revenue of about £40,000, after charging £24,000 to renewal of cables. They generally calculated that a cable should be worked at a cost of 25 or 30 per cent. but theirs had cost 60 per cent., because they had no margin of capital to carry out the extensive renewals necessary in some parts of their system. In order to cure that, and bring about a state of things by which the ordinary shareholder would receive a share in the profits, it was necessary, firstly, that they should pay their debts; secondly, that they should complete the renewal of their cables; and thirdly, that they should have a margin of securities to meet other liabilities. He proposed a scheme by which they could become their own mortgagees, which had met with considerable response, and he believed that, with the assistance of some influential shareholders, they had to-day made an arrangement to provide capital for paying their debts, renewing their cables, and meeting the various classes of debentures falling due next August. That would be the result if the arrangement accepted in principle did not break down in detail, and he thought it by no means unsatisfactory. In conclusion, he referred to certain antagonism they had received from Brazilian officials, which they had every reason to believe was now got rid of by the action of their secretary, who was visiting that country.—Mr. MENDEL seconded the motion, which was carried *nem. con.*—A vote of condolence with the family of Mr. Rawson, the late chairman of the company, upon the decease of that gentleman, was passed; and the retiring directors and auditors having been re-elected, the meeting closed with the customary compliment to the chairman.

THE Globe Telegraph and Trust Company (Limited), notify that interim dividends for the quarter ending January 18th, 1880, of 3s. per share on the preference shares, being at the rate of 6 per cent. per annum, and 2s. on the ordinary shares, being at the rate of 4 per cent. per annum, both free of income tax, will be paid after the 19th inst.

THE directors of the German Union Telegraph Company have declared an interim dividend of 11s. 9d. per £15 bond.

The following are the final quotations of telegraphs for Jan. 13th:—Anglo-American, Limited, 58-58½; Ditto, Preferred, 83-83½; Ditto, Deferred, 33-33½; Brazilian Submarine, Limited, 7¼-7¾; Cuba, Limited, 8½-9; Cuba, Limited, 10 per cent. Preference, 15½-16½; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11-11½; Direct United States Cable, Limited, 1877, 11-11¼; Eastern, Limited, 8⅜-8⅝; Eastern, 6 per cent. Debentures repayable Oct., 1883, 103-106; Eastern 5 per cent. Debentures repayable Aug., 1878, 102-105; Eastern, 6 per cent. Preference, 11¾-12; Eastern Extension, Australasian and China, Limited, 8¼-8¾; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 100-102; Ditto, registered, repayable 1900, 100-102; German Union Telegraph and Trust, 8¾-9¼; Globe Telegraph and Trust, Limited, 5-5¼; Globe, 6 per cent. Preference, 11¼-11½; Great Northern, 8⅝-9⅛; Indo-European, Limited, 23-24; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10¼-10¾; Reuter's Limited, 10-11; Submarine, 230-235; Submarine Scrip, 2⅛-2⅜; West Coast of America, Limited, 1½-1¾; West India and Panama, Limited, 1½-1¾; Ditto, 6 per cent. First Preference, 7½-8; Ditto, ditto, Second Preference, 6¾-7¼; Western and Brazilian, Limited, 5⅜-5⅞; Ditto, 6 per cent. Debentures "A," 100-103, Ditto, ditto, ditto, "B," 98-102; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 105-107; Telegraph Construction and Maintenance, Limited, 35-36; Ditto, 6 per cent. Bonds, 106-108; Ditto, Second Bonus Trust Certificates, 2¾-3; India Rubber Co., 12¾-13¼; Ditto, 6 per cent. Debenture, 105-107.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 168.

INAUGURAL ADDRESS.

By WILLIAM HENRY PREECE (President).

Delivered before the Society of Telegraph Engineers, Jan. 28, 1880.

ON surveying the wide sea upon which the numerous and varied practical applications of Electricity are launched for the subject of this evening's address, I have been puzzled to steer a course that shall avoid the dazzling shoals of theory on the one hand, and the dry, hard rocks of practice on the other. Hypothesis is a veritable Scylla that captivates the imagination and often sends the visionary to destruction, while practice alone is a hard-hearted Charybdis that lures the matter-of-fact practical man to folly and expense. Practice must be tempered with theory to utilise advantageously the great forces of nature, and theory itself must be based on practice, or on facts, to be comprehensive and acceptable. Hence success is the offspring of the marriage of practice and theory, and, therefore, as the two are so intimately connected, I have determined to steer a middle course to-night to survey the progress of each in our profession, and to show their mutual relationship.

What is theory? It is an explanation of the hidden cause of certain effects that are evident to the senses. It is an effort of the imagination to account for operations that are in themselves invisible and insensible, but which result in facts that are observable and known. Thus the movements of all those bright bodies by which

"The floor of heaven
Is thick inlaid with patines of bright gold,"

are explained by the theory of gravity. Their appearance, vagaries, and beauties are accounted for by the undulatory theory of light. The warmth that the monarch of them all shed upon this earth countless ages ago, and that is now restored to us in our household fires, is explicable on the molecular theory of heat. The constitution of matter and its various states of solid, liquid, and gas, are completely explained by the atomic theory of Democritus and Dalton, and the modern kinetic theory of gases.

It is impossible for a practical man who has devoted more than a quarter of a century to the application of electricity to useful purposes to avoid devoting much contemplation to the nature of the agent which he has to make use of. The imagination cannot be checked. The mind will dream and theorise. The untutored savage fancies he hears in the roar of the thunder the anger of the Great Spirit, and the tutored Greek saw in the daily course of the sun the chariot wheels of his god, Helios, and in the grey dawn of the morning the advent of the soft and gentle Aurora. The Saxon churl saw in the lambent flame of the phosphuretted hydrogen of his marshes the gambolings of Jack-o'-Lantern, or the treacherous ways of Will-o'-the-Wisp. Is there a member of this Society who has not striven to peer into the region of the unknown, who has not speculated on the power he uses, or who has not formed some conception in his mind of the nature of electricity? Yet it is remarkable that the answer to the question. What is electricity? cannot even now be given with authority. Faraday, our great apostle, whose researches should be every electrician's bible, declined to venture an answer, nor did he ever directly formulate his ideas on the subject, though his publications indicate pretty clearly and with no uncertain sound, what they were Clerk-Maxwell, who, while he overthrew all existing theories, failed to supply their place before he was so untimely removed from us. Sir William Thomson, in his published papers, always carefully eschews the consideration of any physical theory of electricity. The French electricians simply use the one-fluid theory as a convenience of language, while the Germans, as a rule, employ the two-fluid theory merely for mathematical purposes. Hence there is no recognised theory of electricity. Some maintain, with Du Fay or with Franklin, that it is a form of matter—a substance; others, following Faraday and Grove, consider it a form of force—a motion—like heat and light. It must be either one or the other. There is no other category in which to class it. If it is not a form of matter it must be a form of force. The question I propose to discuss is, therefore, Is electricity a form of matter, or is it a form of force?

In discussing such a vexed question it is necessary to be very precise in language to avoid any misconception of my meaning, therefore I will define both matter and force in the sense in which I use those terms. *Matter* is that which can be perceived by the senses, or can be acted upon by force. It is characterised by weight, inertia, and elasticity. *Force* is that which produces, or tends to produce, the motion of matter. It may be pressure, tension, attraction, repulsion, or anything capable of causing alteration in the natural state of rest or of existing motion of matter.

Matter consists of sixty-four known elements which have not yet been decomposed by any known means. There may be other elements that have not yet been discovered by chemists, but they must exist in some known compound. Matter is found in either the solid, liquid, gaseous, or ultra-gaseous state, and it occupies space. It consists of molecules and atoms. The *atom* is the smallest indivisible part of an element, and a group of atoms of the same or of different elements forms the *molecule*, which has a definite magnitude and is unalterable in form for each substance. The *mass* of a substance is the aggregate of the molecules of which it is composed. There is no generation or destruction of

atoms. The indestructibility of matter is a fixed law in nature. The size of the molecule is approximately known. Sir William Thomson says: "If we conceive a sphere of water as large as a pea to be magnified to the size of the earth, each molecule being magnified to the same extent, the magnified structure would be coarser-grained than a heap of small lead shot, but less coarse-grained than a heap of cricket balls." Fifty million molecules ranged in single file would occupy an inch. They are highly elastic, and unless interfered with would move with constant velocity in straight lines. When they can move about freely without interfering with each other's proceedings, we have the ultra-gaseous state of Crookes, a state found only in very high vacua and under certain adventitious circumstances. When they collide and impinge on each other according to the law of the impact of elastic bodies, interfering with each other's path, we have *gases* as we know them; when their mean free path is so reduced as to bring them within the sphere of mutual attraction, without too narrowly restricting their play, we have *liquids*; when the attraction becomes cohesion, and the motion of the molecule is confined to its own sphere, we have *solids*. The number of molecules in a given volume of gas is known, and their velocity calculated. In hydrogen the velocity at 0° Cent. is 6,097 feet per second, the number being 10^{23} per cubic inch. The mean free path of a molecule in air at ordinary pressures is the ten-thousandth part of a millimetre. Besides their constant motion in straight lines the molecules may be set in vibration, rotation, or any other kind of relative motion whatever.

This is the atomic theory of matter born in the brain of Democritus, "the laughing philosopher," 2,300 years ago; preached by Epicurus in Athens, and taught by Lucretius in Rome before the Christian era; lying dormant for eighteen centuries, until it was formulated by Dalton in the last century, and removed from the region of pure speculation by Joule, Clausius, Clerk-Maxwell, and Crookes during our days.

The definition of force shows us that whatever changes or tends to change the motion of matter (or of the molecules of which it is composed), by altering either its direction or its magnitude, is a form of force. Thus gravity is a form of force, for it attracts all matter to the centre of the earth, and it is measured by the rate per second at which a body acquires a velocity in this direction when falling freely at a given spot. Heat is a form of force, for it throws the molecules of matter into violent vibration, or it increases the velocity of their motion in straight lines, which thus becomes the measure of its heat or its *temperature*. Light is a form of force, for it is produced by the undulation of the molecules of matter, and it is transmitted by the undulations of that medium called Ether, which fills all space.

No man has seen or can see a molecule, nor have we any objective idea of what force really is. When we attempt to reach beyond these definitions, we tread upon the threshold of the holy of holies, on whose confines only are we permitted to dwell, and into which we are not yet allowed to enter. "Hitherto shalt thou come, but no further, and here shall thy proud waves be stayed." Let us, therefore, be content with precise definitions and clear mental conceptions, speculative though they be, of matter inert and of matter in motion. The *ultima thule* of the scientific man is theory, and at any time his most cherished notions may be

"Melted into air, into thin air."

The scientific man, while rather too fond of decrying the exercise of faith in others, is himself the humblest slave of the imagination. A physical theory may be complete. The various facts and laws which it embraces may be related mathematically with one another, yet one single incompatible phenomenon may dissolve it,

> "And, like this insubstantial pageant faded,
> Leave not a rack behind."

Hence, while apparently dogmatic in my description of the present theory of matter and force, I wish it distinctly to be understood that it rests, and must continue to rest, on the imaginative power of the mind.

Nevertheless, subjective speculation may become objective reality. Who is there that doubts the existence of the ether filling all space, transmitting those exquisite and delicate vibrations which impart to us the sensation of light and heat from stars and nebulæ countless millions of miles away? And with regard to the atomic structure of matter, though but a speculation as yet, it is so complete, so apt, and so thorough, that for my part, I have not the slightest doubt of its reality, and therefore I submit it with apparent dogmatism.

When we take a given free mass and impress upon it a given force, we throw that mass into motion; for instance, when we fire a loaded cannon, we have imparted to the ball "*energy*," and in virtue of the motion of the ball, this energy is called "*kinetic*." Again, if we lift the ball to a certain height above the earth's surface—say to the top of a tower—and let it remain there, we have again imparted to it "energy," but this time it is called "*potential*," for it is dormant or resting. In each case the energy possessed by the ball is the exact equivalent of the work done upon it, that is, of the force impressed and the distance through which it has acted. The motion of the ball is readily transferred to the motion of the individual molecules of the ball. When, in the first case adduced, the ball strikes the side of a ship or a target, its kinetic energy is thus converted into light and heat, which is molecular motion; or, in the second case, when it is allowed to fall, its potential energy is converted into kinetic energy, which again, on coming in contact with the ground, is converted into molecular motion or heat. Energy is always either potential or kinetic, and one of the most remarkable generalisations of modern days is the grand principle of the conservation of energy, which implies that the total energy of the universe is a quantity which can neither be increased nor diminished, though it may be transformed into any of the forms of which energy is susceptible. Energy is therefore as indestructible as matter. All the recent advances in the science of heat have been due to the discovery of this principle, and its application to electricity has gone far to remove that science from the hypothetical state in which it has existed so long.

My purpose is to contend that electricity is not a form of matter but a form of force, and that all its effects are evident to us in one or other of the several forms of energy characterised by the motions of molecules or of mass.

It is interesting to trace the historical growth of theories. The uncultivated human intellect cannot soar above its own limited sphere of childish observation. Whatever is mysterious and incomprehensible in nature is attributed to that which is equally mysterious and incomprehensible. Life has ever been of this character, and heat, magnetism, electricity, and many other unaccountable physical phenomena, have each in their turn been supposed to be cases of life. Even now there are those who would attribute exceptional and peculiar phenomena to spiritual agencies.

Heat was thought by the Greeks to be an animal that bit. It was then for many centuries thought to be a fluid which, entering into bodies, like mercury, made them swell, and this idea existed until this generation,

when Rumford showed it to be a kind of motion, and Joule made it a quantitative form of energy.

Thales, of Miletus, thought that the magnet was endowed with a sort of immaterial spirit, and to possess a species of animation. The Greeks knew also that rubbed amber attracted bits of straw, and supposed it to be endowed with life. Even Boyle, as late as 1675, imagined it to emit a sort of glutinous effluvium which laid hold of small bodies and pulled them towards the excited body. Du Fay in 1733 conceived the double fluid theory, and Franklin in 1747 invented the single fluid theory. Cavendish in 1771 supplied some of the deficiencies of Franklin's theory, but it was Faraday who first exploded the fluid notion and originated the molecular theory of electricity, while Grove boldly classed electricity with light and heat as correlated forces and mere modes of motion.

Light was thought by the Platonists to be the consequence of something emitted from the eye meeting with certain emanations from the surface of things, but no theory of light properly so called was attempted until Newton produced his celebrated corpuscular theory in 1670, which has lasted until the present day. Even as late as 1816 Faraday himself said: "The conclusion that is now generally received appears to be, that light consists of minute atoms of matter of an octahedral form, possessing polarity, and varying in size or in velocity."* Although Huyghens in Newton's own time conceived the undulatory theory, the superior authority of the great English philosopher overshadowed the lesser light, and it was not until Young and Fresnel at the commencement of this century took the matter up, that the present theory of light took firm root.

Thus we see that all these sciences have passed through the same stages of mystery and fancy, and it is only within the present generation that they have emerged from the mythical to the natural, from mere hypothesis to true theory. *Hypothesis* is an imaginary explanation of the cause of certain phenomena which remains to be shown probable or to be proved true. *Theory* is this supposition when it has been shown to be highly probable and all known facts are in agreement with its truth.

A theory, therefore, to be valid and true, must agree with every observed fact; it must not conflict with natural laws; it must suggest new experience, and it should lead to further developments. A theory is absurd if it supposes an agent to act in a manner unknown in all other cases. The fluid theories of electricity are merely descriptive, they do not agree with every observed fact; they have never prompted the invention of a single new experiment, or led to any development. They suppose an agent unknown in other cases and opposed to natural laws. Incomplete theories die a natural death, thus Descartes' vortices, Newton's corpuscular theory of light, the fluid theory of heat, Stahl's phlogiston, Nature abhorring a vacuum, have all disappeared, while complete theories, such as that of gravity, the laws of motion, the conservation of energy, the undulatory theory of light, not only remain, but suggest new fields of inquiry, open out fresh pastures, carry truth and conviction with them, and have led to the most wonderful predictions. The fluid theories of electricity are certainly incomplete, and they deserve a speedy interment. We have to assume the existence of two substances of opposite qualities which mutually annihilate each other on combination —a self-evident absurdity, for the conception of matter involves indestructibility. Franklin imagined his one fluid to be an element of glass; remove electricity, and glass would lose its virtues and properties, and thus glass was to give out its electricity for ever and a day, without loss of weight or sensible diminution. It was to be devoid of dimensions, inertia, weight, and elasticity, and is therefore outside the pale of our definition.

* Life, vol. i. p. 216.

Electricity is therefore not a form of matter. Hence, according to our reasoning, it must be a form of force.

But can we not prove that it is a form of force? Certainly.

Let us first argue from analogy. We know that sound, heat, and light are modes of motion, in what respects does electricity agree with these forms of force?

The fundamental law of electrostatics is that two bodies charged with opposite electricities attract each other with a force dependent on the square of the distance separating them. Whatever influence or power spreads from a point and expands uniformly through space varies in intensity as the square of the distance for the area over which it is spread increases as the square of the radius. This is the case with gravity, light, sound, and heat, which are known forms of force. It is also the case with electricity and magnetism, which ought therefore to be similar forms of force.

If we regard the velocity of transmission of certain electrical disturbances through space, we have every reason to believe that it is the same as that of radiant heat and light. In 1859 two observers in different parts of the country (Messrs. Carrington and Hodgson), saw simultaneously a bright spot break out on the face of the sun, whose duration was only five minutes. Exactly at this time the magnetic needles at Kew were jerked, and the telegraph wires all over the world were disturbed. Telegraphists were shocked, and an apparatus in Norway was set on fire. Auroras followed, and all the effects of powerful magnetic storms. Moreover, the periods of sun spots, earth currents, and magnetic storms follow the same cycle of about eleven years. Dr. Hopkinson has shown that this electric disturbance through space is as mechanical as its action through short distances, and is therefore identical with the ordinary strains of elastic matter subject to distortion by mechanical force. But Clerk-Maxwell has gone beyond this, and has shown that the velocity of light is identical with that of the propagation of electrical disturbances through space as well as through air and other transparent media. Hence, as light is admitted to be a mode of motion identical with radiant heat, electricity must be of the same category.

There is such a remarkable analogy between the conductivity of the different metals for heat and for electricity—indeed, there is every reason to believe that if the metals were pure, the order and ratio of conductivity would be identical—that it is impossible to resist the conclusion that the mode of transmission in each case is the same. Mr. Chandler Roberts, who, using Prof. Hughes' beautiful induction-balance, showed, by experiments on a comprehensive series of alloys, that the curves indicating the induction-balance effect closely resemble their curves of electrical resistance. He was also able to demonstrate that the induction-balance curve of the copper-tin alloys is almost identical with the curve of the conductivity of heat: a conclusion of much interest; and he pointed out that we might look with confidence to being able to ascertain, by the aid of the induction-balance, whether the relation between the conductivity of heat and electricity is really as simple as it has hitherto been supposed to be. Moreover, when a wire conveys a current of electricity it is warmed, as the strength of current is increased it is heated and eventually rendered incandescent. The ultimate form which every electric current takes is heat. The wire of every telegraph is warmed in

proportion to the currents it transmits. Joule showed that when this heat is produced by a current generated in a battery by chemical force, its amount is exactly equivalent to that which would have been evolved by the direct combination of the atoms. The conducting power of all bodies is affected by heat, and some even, like selenium, by light. Hence, as we know that in the case of heat and light conduction is molecular vibration, we reasonably conclude that it is the same with electricity. In fact, it is impossible to account for these phenomena except on the assumption of the motion of the molecules.

The magnificent researches of Dr. Warren de la Rue and Dr. Hugo Müller on the electric discharge with the 11,000 cells of chloride of silver battery that the former philosopher has provided himself with in his celebrated laboratory, have shown indisputably that the discharge in air or in gases under various pressures is a function of the molecules filling the space through which the discharge occurs. In fact, the resistance of the discharge between parallel flat surfaces is as the number of molecules intervening between them; and they show that during electrical discharge in a gas there is a sudden and considerable pressure produced by a projection of the molecules against the sides of the containing vessel distinct from that caused by heat, and unquestionably due to the molecular action of electrification. The long-continued and patient researches which these eminent physicists are carrying out prove beyond doubt that electrical discharge is simply molecular disturbance. In reality, the fact that no discharge occurs through a perfect vacuum is a crucial proof of the molecular theory.

Some recent very remarkable researches of M. Planté with his rheostatic machine* have shown that fine wires conveying powerful currents are wrinkled up into well defined regular nodes, that these effects are accompanied by a peculiar crackling, and that the wire itself becomes brittle, giving clear indication of the vibratory motion of the molecules. He gives as the result of his inquiry that electrical transmission is the result of a series of very rapid vibration of the more or less elastic matter which it traverses, and he points out certain analogies between electric motion and sonorous vibrations. This view has been supported by the researches of Professors Ayrton and Perry† on the viscosity of dielectrics.

Professor Challis, of Cambridge, has extended this view so far as to embrace magnetism, electricity, light, heat, and gravity in one category of physical force, and to assert that they all result from motions and pressures of a uniform elastic fluid medium pervading all space not occupied by atoms. His views, however, have not received much attention, for they are not based on the foundation of any new facts, and they are utterly subversive of many cherished principles deeply rooted in the scientific mind. It is to be observed, however, that he regards electricity as a form of force.

Mr. Crookes in his recent beautiful experimental researches into molecular physics in high vacua has still more conclusively proved the connection that exists between electrical action and molecular motion. In fact, his experiments are so brilliant, his expositions so lucid, that one can fancy one sees with the eye of the body that peculiar play of the molecules which can be evident only to the eye of the mind. Not only has Mr. Crookes established as a physical fact the kinetic theory of gases, and the molecular constitution of matter, but he has indicated the existence of a fourth state of matter where the molecules fly about without mutual let or hindrance. He has also led us to doubt the truth of the generally received opinion that an electric current flows from the positive to the negative electrode. It would appear from his investigations that the reverse is the case. Be that as it may, he has added one storey to the structure of the molecular theory of electricity.

The criterion of a good theory is, however, its power of prediction. A false theory has never led to prevision. Neither the corpuscular theory of light, nor the fluid theories of heat and electricity, ever led to the prediction of something of which eyes had not seen nor ears heard. The triumphs of prediction in astronomy, sound, light, and heat are innumerable. Faraday predicted the effect of induction in lowering the velocity of currents of electricity and the action of magnetism on a ray of light. Sir William Thomson predicted that a current in passing from a hot to a cold part of a copper bar would heat the point of contact, while in an iron bar it cools it. Peltier predicted the cooling effect of currents on the junctions of thermo-electric pairs.

But the true identity of these physical effects is conclusively shown by their quantitative character, and by their adhesion to the law of the conservation of energy. Take the case of the electric light: the consumption of coal in a furnace generates steam, the steam works an engine, the engine rotates a coil of wire in a magnetic field, the motion of the coil in this field induces currents of electricity in the wire, these currents of electricity produce an arc, and thereby heat and light. The energy of the coal is transformed into heat and light through the intermediate agency of electricity. Is it possible to conceive that this intermediate agency is anything but a form of energy? Take the case of the Bell telephone: the energy of the voice produces the energy of sonorous vibration in the air, the vibrations of the air cause the vibrations of the iron disc, the vibrations of the disc vary the magnetism of the magnetic field, this produces currents of electricity in a small coil in this field which vary the magnetism of the distant magnet, which in its turn throws its disc armature into vibration, and thereby repeats at the distant station the sonorous vibrations of the air, and thus reproduces the energy of the voice. A tuning-fork comes to rest sooner in front of a telephone than when it is allowed to vibrate freely in air. Here we have the energy of the for passing through the several stages indicated above and ultimately come out in its original form. Th energy of sonorous vibrations at the distant station i that lost by the vibrating tuning-fork.

Is it possible to assume that in this cycle of chang energy has been transformed into matter and matt again formed into energy? It is impossible and absur Clerk-Maxwell said: "When the appearance of o thing is strictly connected with the disappearance another, so that the amount which exists of the o thing depends on and can be calculated from t amount of the other which has disappeared, we co clude that the one has been formed at the expense the other, and that they are both forms of the sa thing."

Would it be possible to light the streets of Ne York by the energy of the falling water at Niagara, has been suggested by our Past President, Dr. Siemen if the cycle of changes from the one spot to the oth were not all different forms of this same energ Would it be possible to plough a field a mile away fro the source of motive power of the transmitting mediu if the electric currents were not forms of the sa power? Electricity in its effects is and must be a for of energy.

* Comptes Rendus, lxxxix., pp. 76—80, 1879.
† Pro. Roy. Soc., pp. 7, 8, No. 186, 1878.

The final stage into which any physical theory grows is that in which every action can be expressed in mathematical language, where every phenomenon is calculated upon an absolute physical basis, and where we can foretell exactly what will occur under any possible emergency. This is the present condition of the science of electricity. We can calculate exactly how much steam power is required to generate a given current to produce a given light. We can tell precisely what dimensions of cable are necessary to give a certain number of words per minute on the other side of the globe. If a fault develop itself in a long cable through the gastronomic propensities of a thoughtless young teredo, we can calculate to within a few fathoms the locality of his edacious depredation.

Take, again, the conversion of heat into electricity, and of electricity into heat, of chemism into electricity, and of electricity into chemism—but I am tired of these illustrations. It may suit a Darwin or a Faraday, to satiate his pupils with a plethora of illustrations to carry his point, or it may suit an author who is writing a book to exhaust his subject, but the President of a Society in his inaugural address must regard the time before him and the patience of his readers. I have shown that electricity is not a form of matter, and I hope I have now convinced you that it must be a form of force. In its effects which are known to us, it must rank as one form of energy in the same category with chemism, with light, and with heat, as a peculiar mode of motion of the molecules of matter.

Clerk-Maxwell,* in his classical work on electricity, has used a somewhat curious argument to show that electricity is not, like heat, a form of energy. He says that energy is produced by the multiplication of "electricity" and "potential," and that it is impossible that electricity and energy should be quantities of the same category, for electricity is only one of the factors of energy, the other factor being "potential." But this does not militate in any way against the force of the argument, for in nature we can no more do so than we can separate heat and temperature. Energy usually appears as the product of two factors, and it is the equivalent of the work done. Thus, *Potential energy* is the product of mass and gravitation acting through a distance. *Kinetic energy* is the product of mass and the half-square of velocity. The energy of fluids is the product of volume and pressure. The energy of heat is made up of heat and temperature, and the energy of electricity is the product of electricity and potential. Hence it is that electricity, *per se*, may be said to be a form of force, while all its effects as known to us are forms of energy. Force alone cannot produce energy; it must be force and something else. Force is the power of producing energy, and it must have something on which to produce it. Hence matter is always present; and thus, though heat, light, and electricity are forms of motion, they are in reality properties of matter from which they are inseparable. They are evident to us through the play of the molecules of matter, and thus are properly called molecular forces.

Our Society was established for the general advancement of electrical and telegraphic science, and more particularly for facilitating the exchange of information and ideas among its members. The advancement of physical science is as much our duty as is the furtherance of the art of telegraphy. Complaint has been made that we have devoted ourselves too much to the ventilation of purely concrete matters, while abstract questions have been neglected. There may be some truth in this stricture on our proceedings, and there may even be a cause for it. The Council are now seriously considering, not perhaps so much an enlargement of the scope of the Society as an alteration in its title, which will prevent any misconception as to its aims and purposes. Though the science of electricity is very advanced, there is still vast room for research, and our widely scattered members, spread all over the face of the globe, with the most costly and perfect apparatus at their command, have a grand opportunity to further the objects of the Society, if they only avail themselves of the means at their disposal. Every science, and especially our science, is the outcome of intelligent observation and careful experiment. There is no science that owes so much to its practical employment for useful purposes. The science itself has grown with the art of telegraphy. Practical difficulties have suggested inquiry, inquiry has prompted trial, trial has opened the eye of the mind to further development, and the result is that the highest scientific authorities acknowledge their indebtedness to the telegraph engineer. The historical inductive philosophy of Bacon is supposed to teach us that to establish science on a true basis we must accumulate a vast array of facts, marshal them in proper methodical order, and extract from them laws. But this is not the natural order, nor is it the method pursued by Newton, Faraday, or any great master of science. Joule has spoken of "a new era in the history of science, when the famous philosophical system of Bacon will be to a great extent superseded, and when, instead of arriving at discovery by induction from experiment, we shall obtain our largest accessories of new facts by reasoning deductively from fundamental principles."*

Faraday said: "I must keep my researches really *experimental*, and not let them deserve anywhere the character of *hypothetical imaginations*."† Nevertheless, all Faraday's researches are characterised by the hand following the brain; by observation and experiment checking, as it were, the speculations of thought. For forty years he pursued his pet notion of the connection between magnetism and light. He was sure it existed, but it took him twenty-three years to prove it.

Jevons said: "Modern science is not the result of the Baconian philosophy, it is the result of the Newtonian philosophy and the Newton method. The 'Principia' is the true 'Novum Organum.' It is the result of theory guiding experiment, and yet wholly relying on experiment for confirmation; the brain guiding the hands."‡ In our practice difficulties have suggested remedies, effects have suggested causes, hypothesis has suggested experiment, and experience has confirmed or refuted the hypothetical anticipations of the fertile brain. The difficulties in working underground wires, and in cables, suggested to Faraday and to Thomson those researches which have placed the laws of induction on "the solid ground of nature." The necessities of the telegraph engineer prompted the members of the Committee of the British Association to labour with such success as to bring the physical quantities of electrical elements within the fold of exact and absolute measurement. We glory in the present day in the perfection of apparatus which the requirements of telegraphy have evoked, and experiments which Newton would have thought too minute to fall under the observation of our senses are repeated every day. The indications of Thomson's reflecting galvanometer, and the beats of Bell's telephone are only equalled by Whitworth's gauges and by spectrum analysis.

The development of ocean cables has opened a new

* Vol. i. p. 30.

* Phil. Trans. 1858.
† "Life of Faraday," vol. ii. p. 35.
‡ "Principles of Science," vol. ii.

world to the scientific observer, and *Porcupines*, *Lightnings*, and *Challengers* have probed the deep unfathomed caves of ocean, swept the bed of the mighty deep, and scoured the surface of the seas, to search out new facts, and to open up fresh fields for the naturalist, the biologist, and the meteorologist. There are many questions that remain unanswered, and that offer work for our members: the distribution of atmospheric electricity, the conductivity of the atmosphere, the cause and nature of earth currents, the electrical relation that exists between the sun and the earth, the cause of electrification or polarisation in insulated wires, the various phases of induction, and many other points deserve inquiry for report to the Society for discussion at our meetings, and for record in our proceedings.

Earth currents have been a favourite subject of inquiry of mine for many years. I have always entertained the idea that they are directly due to the action of the sun. Some disturbance in the sun causes, by induction, a variation in the distribution of the lines of potential on the earth's surface, and produces the conditions required for these currents. I have many facts to support this hypothesis, but I want more to confirm it. Professors Ayrton and Perry have developed a theory of terrestrial magnetism based on the assumption that the earth is a highly electrified sphere, which not only coincides well with facts, but which tends greatly to support my views. I want observers to record the times of daily maxima and minima. I want them especially to note during those periods of unusual disturbance the direction of the circuits which are *not* affected, for they would give the direction of the lines of equipotential. This not only offers a useful field of observation, but its failure or success will illustrate the modern method of scientific research, when the brain suggests to the hand and the eye what they have to do, and what they have to look for.

Our Society not only offers a useful field for scientific research, but it supplies a very useful arena for the education of its members. We shall shortly have open to their perusal the finest electrical library in the world—that of Ronalds, and we have the hopes in the future of having added to it an equally famous one, collected by one of our most eminent Past Presidents.

But knowledge gained from books should be confirmed by experience. We are too much apt to rely on illustrations, and think we know all because we can illustrate it by pen or pencil. Many a bright idea is lost for want of an opportunity to test its validity. Those who reason theoretically without demonstrating experimentally are sure to fall into error, while those who experiment in a haphazard way without being guided theoretically, are sure to waste time and money. I want, therefore, to see our library supplemented by a laboratory, where those of our members who have not the means at their disposal, can not only confirm their reading, but go and examine their ideas for themselves by the rigorous test of experiment. We are not all Hughes who can make scientific apparatus out of lucifer boxes and bonnet wire. If the financial abilities of our Hon. Treasurer prove as successful in the future as they have done in the short career which has distinguished his past occupation of the office, I have little doubt that this wish will be within reach of accomplishment.

There is no more useful mode of imparting knowledge than that of lecturing. "It blesseth him that gives and him that takes." The lecturer often learns more than his audience. The possession of a laboratory would enable us to ask those who have made any special line of study their own, to favour us occasionally with a *viva voce* explanation of their researches and their views. Several societies practise this salutary plan, which is one that was very strongly advocated by Faraday.

Our proceedings form a most useful vehicle for the promulgation of new facts. History tells us of many brilliant experiments and discoveries that have been hidden and neglected from the want of proper publication, or of some society to take them up. Thus Mayow, a doctor of Bath, discovered oxygen over 100 years before it was re-discovered by Priestley and Scheele. Romagnosi, a doctor of Trent, discovered the deflection of the needle 15 years before Oersted startled all Europe with its re-discovery.

The great cry of to-day is for technical education. Here we have an organisation well suited for furthering this object, and with a home of our own, an unequalled library, and a well-equipped laboratory, we ought to be able to stifle the cry, at least as far as telegraphy is concerned.

The science of electricity owes its great development to the vast extension of submarine telegraphy throughout the oceans of the world. The Atlantic has been crossed by no less than nine cables, of which three, however, are dumb. A thin cord duplicated the whole way, extends from England to Australia, it is duplexed to India, and one wire extends from Aden to the Cape. There are no less than 97,568 miles of submarine cable now in working order. In spite of the wail of distress that has depressed the commercial world, cable enterprise has not fallen below the average during the past year.

During the past twelve months the Telegraph Construction Company has manufactured 6,800 knots, Siemens Brothers 3,600 knots, the Silvertown Company 900 knots, and Mr. Henley 107 knots of cable—11,407 knots of cable laid by commercial enterprise in all quarters of the globe in one year!

The maintenance of the long mileage of cable requires the employment of a fleet of ships. There are now no less than 27 steamships employed for telegraphic purposes in different parts of the globe. They are all well officered, and specially fitted up with machinery and apparatus to facilitate their operations. They are each provided with a skilled staff specially trained to observation and experiment. We are much indebted to Mr. Jamieson for a very interesting paper on Cable Grappling and Lifting, but with this exception we have little or nothing to chronicle of their doings. It is surprising how few are the facts that have been added to our knowledge by such an organisation. It is owing certainly not to want of zeal, but perhaps to an ignorance of what is needed. If they were to study Sir Wyville Thomson's "Depths of the Sea," or his "Voyage of the Challenger," if they were to provide themselves with a good microscope, with sample bottles and alcohol, they would be surprised to find how much they would increase their own enjoyment, afford gratification to their friends at home, and further the interests of science. Indeed, ocean life is becoming a source of considerable anxiety to the telegraph engineer, for many little creatures have developed a decided *penchant* for the constituents of which cables are composed. In all the recent cables laid within depths of 100 fathoms by the Telegraph Construction Company a wrapping of thin brass has been externally applied to provide for this growing evil. Damage to the gutta-percha has not been observed at greater depths than 100 fathoms, but some specimens of the Atlantic Cable of 1865, which have recently been recovered from a depth of 2,000 fathoms, gave unmistakable evidence of the destruction of the hemp by some boring animal.

At home the greatest advances have been made in apparatus. The mileage of wire that has been erected

in England to meet the enormous increase of telegraph business that has occurred since 1871 is trifling. The average weekly number of messages in the month of October, for the former year, was 273,000; the greatest number ever reached at that time, while for this last year it amounted to no less a figure than 586,000. This great increase has really been provided for by the improvement in Wheatstone's Automatic Apparatus; by the introduction of duplex working, and more recently by the quadruplex system. The duplex and quadruplex systems have been proved to be applicable to automatic working, and the speed of working long circuits has been much increased by the insertion of intermediate relay stations. But we have reached a limit; our system is actually gorged with messages; failures of wires cause considerable trouble, inconvenience, and complaint, the public—our watchful, but not lenient masters—are beginning to growl, and the erection of additional wires has become essential. It is hoped that a new trunk line to the North and many additional wires will be erected during the ensuing summer. There is also strong reason to believe that for the first time since the acquisiton of the Telegraphs, the balance on the right side will be sufficient to show a surplus over the dividend on the capital expended in the acquisition of telegraphs by the State.

The improvement of apparatus in this country is a veritable case of growth by evolution. The instruments themselves are in a constant state of transition. Every defect or deficiency, as it develops itself, is removed, and the result is that the instrument grows by a process of careful cultivation and of intelligent selection, prompted by experiment, guided by theory, and confirmed by practice. It is not too much to say that in quality of manufacture, efficiency of performance, and perfection of design, the apparatus of this country takes its position in the very front rank. This applies not only to the apparatus used by the Post Office, but essentially to that employed by the Cable Telegraph Companies. Even lately a very great step forward has been made by Mr. Harwood, of the Eastern Telegraph Company, who has recently much improved the duplex working of cables both as regards speed and efficiency.

The cry that invention has been checked by the monopoly of the Government is made by those who are ignorant of contemporaneous history, who are too callous to inquire for themselves into the truth of the accusation, and with whom most probably the wish is father to the thought.

The telephone—the great excitement of the previous session—has made but little progress during the past year, though there is no doubt that, through the discovery of the principle of the microphone by Professor Hughes, the practical applications of that wonderful instrument have been much improved. In fact, Professor Graham Bell, Mr. Edison, Mr. Elisha Gray, and all those who have been working in this field, have laid aside their own particular form of transmitter, and have adopted one that is a mere form of microphone. In England we have one or two excellent forms. Those of Mr. Louis Crossley and Mr. Hunnings leave little to be desired, while in America that of Mr. Francis Blake is admirable, and is also much used in England.

Litigation has commenced between the Post Office and the Telephone Companies, not to restrict, or in any way to interfere with the use of the telephone; but to prevent the establishment of a particular branch of post-office telegraph business without its licence or consent.

A curious controversy as to the seat of the vibrations which result in the reproduction of speech has occupied the attention of certain physicists on the other side of the Channel. Some, following Graham Bell, and led by Count du Moncel, attribute the effect solely to what may be called the Page effect, viz., a molecular disturbance of the magnet itself. Others, led by Colonel Navez, prefer to follow me in a theory I first propounded at Plymouth,* viz., the sonorous vibrations are set up by the mechanical movement of the disc itself. Both theories are really true, and the controversy is, like many other scientific controversies, a war of words. The motion of a mass is the integration of the motions of the molecules of the mass. There is the Page effect in the magnet, and there are the effects of magnetic attraction on the disc; the resultant action being sonorous vibrations. In point of fact, there would be no sonorous vibration if there were no molar motion, and there would be no molar motion if there were no molecular disturbance.

The electric light has been making considerable progress, and is gradually forcing itself into practical use, in spite of many of the drawbacks to its employment that have yet to be removed. The lamp of the future has not yet been produced, though steadiness and duration have very much advanced during the past twelve months. There is very little room for improvement in the generating machine, for both the Siemens and Gramme machines convert about 90 per cent. of the energy thrown into them into electric currents, and this is a duty which no other kind of machine can show.

One of its most notable and useful applications has been on board ship, to further the operations during the night in laying and repairing cables. I was present on board the s.s. *Dacia*, in the Mediterranean, when this was done, and the success was unequivocal.

The Brush machine has recently been introduced into this country, and its performances are certainly very wonderful. It produces an electromotive force of over 800 volts, and I have seen it maintain twenty very steady arcs joined in series. Sixteen appear to be its efficient limit, and this number of lamps, giving over 1,000 candlepower, are easily maintained by an expenditure of 13½ horse-power. The performances of the Brush light are certainly the most advanced form the electric light has yet taken. There are over eight hundred of these lights in the United States; and it is worthy of notice that it has quietly crept into existence without the aid of the ubiquitous and omniscient newspaper correspondent, or the transmission of any sensational telegrams, to the detriment and discomfort of gas shareholders.

It is assumed by many that the electric light is devoid of heat, but Professor Dewar has shown that a Siemens arc radiates heat equivalent to 3 horse-power per minute. Moreover, the use of such powerful currents, unless carefully directed, are dangerous to life and limb, and may even, unless properly protected, result in fire.

Gas is not going to be affected by the electric light. The proper function of gas is to generate heat. Ninety-four per cent. of the ingredients of gas are consumed in generating heat, and only six per cent. in producing light. It is remarkable that so amenable and tractable an agent for heating purposes has not been more utilised, but the fact is that the public is ignorant of its properties, careless of its employment, and callous of its defects. It is not too much to say that fifty per cent of the gas manufactured is absolutely wasted for illuminating purposes by the wild extravagance with which it is burnt, and by the want of those systems of regulation which have been introduced to compensate for irregularities and excesses of pressure.

* British Association Meeting, 1877.

The utilisation of the illimitable wasted energy on the earth's surface offers a fine field for the ingenuity of the electrician. The tides of the ocean, the motion of the atmosphere, the rapids of a river, the innumerable waterfalls that are found in every mountainous or hilly country could be compelled to give up in the form of electric currents that energy which gives them existence, and which could thus be employed for providing power, generating heat, or supplying light, away altogether from their source of conversion. In fact, Sir William Armstrong, near Newcastle, and an enterprising hotel proprietor in Switzerland, have already produced light in their houses by converting into that form the energy of a neighbouring waterfall.

I cannot omit mentioning the researches of Professor Hughes. Here we have the case of a telegraphic engineer who has spent the best part of his life in improving the working of telegraphs, resting from his labours with well-lined purse, and turning philosopher. Spurning the costly apparatus of the philosophical instrument maker, he takes the simplest and cheapest materials he can lay his hands on, and with fine inventive skill, aided by an instinctive mechanical turn of mind and well-trained hand, he forces nature to develop unexpected secrets, and he enables the chemist of the mint to detect an infinitesimal trace of impurity in the bright golden sovereign. Moreover, he has not only detected an absolute zero in nature, but he has given the physician a standard by which he can measure the relative sensitivity of the dullest and sharpest ears. His induction balance and audiometer are fit sequels to his microphone, and I venture to predict that he will yet wring out of Dame Nature some other facts that have lain dormant since the first fiat went forth, "Let there be light." His mode of investigation is a very apt illustration of the practice I have previously described as so successful in modern scientific discovery, of making experiment subservient to hypothesis with the view of furthering science. His investigations have been made without the slightest idea of gaining filthy lucre or of taking by a flank movement some successful inventor's patent—practices which, I am sorry to say, in these immoral times are far too frequent to be palatable.

We cannot but congratulate ourselves upon the position of our Society. Our first President, Dr. Siemens, in the first paragraph of his inaugural address, remarked that, "Some years must necessarily elapse before our Society can have given substantial proof of its useful action." I venture to submit that those years have passed. Our success has exceeded the most sanguine anticipations. Our work has been thought of sufficient importance to merit special reference in the first annual address of the gifted and able President of the Royal Society. The good that our Society has done and is doing is patent to all. It stimulates thought, it encourages experience, it furthers the science, and it develops the art of telegraphy. It inculcates knowledge, and is, therefore, educational; it records results, and is, therefore, historical; it cements friendship and promotes good fellowship, and it has, therefore, a moral influence; but, above all, it knits together in one family bond that great wide-spread brotherhood who are found scattered in every quarter of the world, maintaining and operating "The wonder-working wire," to the annihilation of space and the economy of time.

The Second Course of Cantor Lectures for the present Session of the Society of Arts is on "The Manufacture of India-rubber and Gutta-percha," by Mr. Thomas Bolas, F.C.S. The course commences on February 2, and will be continued on successive Mondays, till March 8.

JAMES CLERK MAXWELL, F.R.S.

(*Continued from page 21.*)

While Professor of Physics at King's College, London, Maxwell was engaged as a member of the British Association Committee in the determination of the Absolute Unit of Electrical Resistance, and it was the comparison of electrical units which attracted a great part of his attention during his tenure of his Cambridge Professorship. He always spoke very highly of Faraday's "Experimental Researches," which he read very early in life, and to which he attributed some of his most useful ideas on electricity and electro-magnetism. In Clerk Maxwell Faraday found a mind constituted after the same plan as his own, but with the advantage of a mathematical training, which has made Professor Maxwell capable of interpreting Faraday's bold realisations to the mathematical world. For Clerk Maxwell's own views of Faraday the reader may be referred to the article "Faraday," in the ninth edition of the "Encyclopædia Britannica," and to his papers on "Faraday's Lines of Force," read before the Cambridge Philosophical Society in 1855 and 1856.

It is impossible in a sketch like this to give anything but the most superficial view of a character so noble in all its aspects as that of Clerk Maxwell. As a professor he was wonderfully admired by those who were truly his disciples. He had not the power of making himself clearly understood by those who listened but casually to his pithy sentences, and consequently he was not a so-called popular lecturer; nor was he a most successful teacher of careless students. But when he had those about him who could enter into his mind, and, receiving the golden truths from his lips, could alloy them in such a way as to make them acceptable to the ordinary student, no better teacher could be desired, even for the most elementary instruction. His wonderful imagination was of great value, not only in supplying illustrations for didactic purposes, but in suggesting analogies and opening up new fields for research, though in the lecture-room it sometimes carried him on more rapidly than the ordinary members of his class could follow.

The pages of *Blackwood's Magazine* (Nov., 1874) can testify to his talents as a poet; his sense of humour and his ready wit formed remarkable features in his character, in fact he seldom talked for many minutes without provoking at least a smile. (Some of the reviews lately contributed by him to *Nature* may serve as illustrations.) He was well versed in all the literature of the day, and seemed to have investigated on his own account every system of philosophy. He took great interest in passing events, though he never indulged in political discussions. As an experimentalist he was too well known to require description; in that region of science which was his *par excellence*, viz., the domain of Molecular Physics, he stands without a rival. But there were other sides of his character which outshone even his scientific attainments. Such complete unselfishness and tender consideration as he exhibited for those around him, and especially for those under his control, are seldom to be met with. During the eight years that he held the chair of Physics in Cambridge he never spoke a hasty

word, even to his attendants. His self-sacrificing devotion to those he loved was the marvel of his friends. Though he never entered into theological controversy, and only occasionally in his scientific writings indicated in a sentence or two the side he took in questions which have recently been brought prominently before the public by some of the more popular men of science, those who had an opportunity of seeing into his home-life knew him to be an earnest Christian. About three weeks before his death he remarked that he had examined every system of Atheism he could lay hands on, and had found, quite independently of any previous knowledge he had of the wants of men, that each system implied a God at the bottom to make it workable. He went on to say that he had been occupied in trying to gain truth, that it is but little of truth that man can acquire, but it is something to "know in whom we have believed." His simple Christian faith gave him a peace too deep to be ruffled by bodily pain or external circumstances, and left his mind free to the last to contemplate all kinds of questions of general interest. One day not long before his death he had been puzzling himself in vain endeavours to discover why Lorenzo ("Merchant of Venice," Act. v. scene 1), whose character was at least far from noble, says to Jessica—

> "Look how the floor of heaven
> Is thick inlaid with patines of bright gold:
> There's not the smallest orb which thou beholdst
> But in his motion like an angel sings,
> Still quiring to the young-eyed cherubins;
> Such harmony is in immortal souls;
> But while this muddy vesture of decay
> Doth grossly close it in, we cannot hear it."

We may quote one other example illustrating how the speculative character of his mind remained to the last. About five or six days before his death, when he was suffering from such extreme weakness that he could say very little, after lying motionless with his eyes closed for some time, he presently looked up and remarked, "'Every good gift and every perfect gift is from above, and cometh down from the Father of lights, with whom is no variableness, neither shadow of turning.' Do you know that is a hexameter?

> 'πᾶσα δόσις ἀγαθὴ καὶ πᾶν δώρημα τέλειον,'

I wonder who composed it."

His knowledge of hymns and hymn-writers was very extensive, and he took great pleasure during his illness in reciting from memory some of his favourites among the writings of Richard Baxter, George Herbert, and others.

To attempt to give any adequate idea of his contributions to science in a sketch like the present would be but to mislead the reader. His great work on "Electricity and Magnetism," the second edition of which is now in the press, is the admiration of mathematical physicists. More generally known are his treatise on the Theory of Heat, and his little text-book entitled "Matter and Motion," which was published by the S.P.C.K. His first paper, communicated by Forbes to the Royal Society of Edinburgh, on "The Description of Oval Curves and those having a plurality of foci," is dated 1846. His paper on the "Theory of Rolling Curves" was communicated to the Royal Society of Edinburgh by Prof. Kelland, and read on February 19, 1849, when Clerk Maxwell was an Edinburgh student barely 18 years of age. His paper on the "Equilibrium of Elastic Solids," above alluded to, was read before the same society on February 18, 1850. His paper on the "Transformation of Surfaces by Bending" was read before the Cambridge Philosophical Society on March 13, 1854, about two months after taking his degree. This was followed in December, 1855, and February, 1856, by papers on "Faraday's Lines of Force." In 1857 he obtained the Adams Prize in the University of Cambridge, for his paper on the "Motions of Saturn's Rings." His paper on the "Theory of Compound Colours, and the Relations of the Colours of the Spectrum," which was chiefly instrumental in gaining the Rumford Medal, was read before the Royal Society on March 22, 1860. His "Dynamical Theory of the Electromagnetic Field," including a brief sketch of the Electromagnetic theory of Light, was read before the Royal Society on December 8, 1864. The results of Clerk Maxwell's experiments on "The Viscosity and Internal Friction of Air and other Gases," were made known to the Royal Society in the Bakerian Lecture read February 8, 1866. Then follow his Royal Society papers "On the Dynamical Theory of Gases," in May, 1866, and "On a Method of Making a Direct Comparison of Electrostatic with Electromagnetic Force, with a Note on the Electromagnetic Theory of Light," in June, 1868. Lately he took great interest in Graphical Statics, and contributed a long paper "On Reciprocal Figures, Frames and Diagrams of Forces," to the Royal Society of Edinburgh, in December, 1869. This paper obtained the Keibb Medal. Among his most recent papers are a paper on "Stresses in Rarefied Gases arising from Inequalities of Temperature," read before the Royal Society on April 11, 1878, and a paper on "Boltzmann's Theorem," read before the Cambridge Philosophical Society. It would take too long to enumerate his articles and reviews published in the *Philosophical Magazine* and in *Nature*. His contributions to the ninth edition of the "Encyclopædia Britannica" include the articles "Atom," "Attraction," "Capillary Action," "Constitution of Bodies," "Diagrams," "Diffusion," "Ether," "Faraday," and "Harmonic Analysis." "Harmonic Analysis" was the last article he wrote. In 1870 Clerk Maxwell was president of the Mathematical and Physical section of the British Association. His presidential address on the "Foundation Stones of the Material Universe" is too well remembered to require more than a passing reference.

One of the most remarkable of his works is the recently-published volume of the Electrical Researches of the Hon. Henry Cavendish, of which Professor Maxwell is the editor. The MSS. are in the possession of the Duke of Devonshire, and are now at Chatsworth. They were intrusted by him to Professor Maxwell shortly after the completion of the Cavendish Laboratory. Some of Cavendish's experiments were repeated by Professor Maxwell with all the appliances of modern apparatus, and others were carried out by his pupils.

Most of the apparatus which he employed in his researches has been presented by Professor Clerk Maxwell to the Cavendish Laboratory, together with many of his books. He always regarded the

laboratory with great affection, and the University owes much to his liberality. One of the most interesting pieces of his handy-work now preserved in the laboratory is a plaster model of Professor Willard Gibbs's thermodynamic surface, described in the fourth edition of "Maxwell's Theory of Heat." All the lines on the surface are drawn by his own hand, many of them being mapped out by placing the surface obliquely in the sunshine and marking the boundary between light and shade. Another valuable model constructed while Professor Maxwell was at Cambridge is his dynamical illustration of the action of an induction coil, in which two wheels represent by their rotation the primary and secondary currents respectively, the wheels being connected through a differential gearing to which a body of great moment of inertia is attached, the rotation of which represents the magnetism of the coil. A friction break represents resistance, and a spring may be attached to the secondary wheel to represent the capacity of a condenser placed in the secondary circuit. Among other valuable pieces of apparatus presented by Professor Maxwell to the laboratory are the receiver, plates, and inertia bar employed in his researches on the viscosity of air and other gases, his colour-top, portions of the "colour-box," including the variable slits, with the wedge for measuring their width, a polariser and analyser made of thin films of stretched gutta-percha, the mechanism for illustrating the motion of Saturn's rings, a real image stereoscope, and the dynamical top, whose moments of inertia about three axes, which are at right angles to each other, can be so varied by means of screws that the axis of rotation can be made that of greatest or of least moment of inertia. When the axis of rotation is the mean axis, the motion of the top is, of course, unstable. When Professor Maxwell came to Cambridge in 1857 to take his M.A. degree, he brought this top with him from Aberdeen. In the evening he showed it to a party of friends in college, who left the top spinning in his room. Next morning he espied one of these friends coming across the court, so jumping out of bed, he started the top anew, and retired between the sheets. The reader can well supply the rest of the story for himself. It is only necessary to add that the plot was completely successful.

Professor Clerk Maxwell's papers will be placed in the hands of Professor Stokes, who is one of his executors, in order that they may be published or catalogued and preserved in such a way as to be readily available to those wishing to consult them.

A committee has recently been formed in Cambridge, having for its chairman the Master of Trinity, for the purpose of obtaining a memorial of Professor Clerk Maxwell. It is strongly felt by many that the memorial should be distinctly personal, while the advantages to be derived from the publication of Professor Maxwell's scattered papers in a collected form are admitted by all. The objects which appear to meet with most favour are (1) a marble bust, (2) a portrait, and (3) the publication of Professor Maxwell's papers and the presentation of copies to the principal libraries and laboratories. It is hoped that the funds collected will be sufficient to enable the committee to carry out each of these proposals.

Wm. Garnett.

A LIQUID VOLTAIC ARC.

By C. V. Boys, A.R.S.M.
(Read before the Physical Society.)

In the spring of last year, while I was experimenting with Dr. Guthrie on liquid conductivity, it happened that I connected, with a piece of fine steel wire, the poles of the five-cell Grove's battery which drove the Froment engine. The result of this and of the few experiments which it led me to try are of such interest as to induce me to bring them before the Physical Society.

As was to be expected the steel melted and was oxidised, and the fused oxide remained attached, part to each wire. On bringing these globules of oxide together, before they had cooled, they instantly joined together, attained a very high temperature and gave out a brilliant light. On separating the wires gently the globule of oxide stretched, and became longer and thinner and hotter and so gave a brighter light, but its want of cohesion caused it to give way just as it was increasing very rapidly in brilliancy. As this result was obtained at the time of the electric light panic, I was naturally led to hope that this liquid arc, as I rather improperly called it, might develop into a useful source of light and, therefore, the few experiments that I tried upon it were made with a view to test its value as an illuminating agent.

As glass, when hot, has considerable cohesion, and also conducts electricity well, I thought I might improve the light-giving qualities of the melted oxide of iron by adding a little glass, and so producing a compound silicate containing iron. On touching it with a capillary glass tube I found I was fully justified in my conclusion, for not only could I draw it to a greater length now than before; but, even before this stretching, it gave a better light due to the increased resistance. But much glass had a disadvantage in this respect, if the liquid arc once became at all cool it was a very troublesome matter to start it again. Beside glass I tried a variety of bodies, silica, alumina, clay, lime, oxide of chromium, fluor spar, &c., without noticing any very peculiar effect except that the positive pole was always the hottest. I tried several methods of supporting the arc, and of regulating it, with only partial success, but they are not of sufficient interest to justify me in taking up your time with an account of them.

This liquid arc is of great interest in another respect, for a liquid salt should be electrolysed by the passage of a current through it. To what extent electrolysis took place in the few experiments that I made I am not prepared to say, as I have had no time to examine the properties of the arc in a methodical or quantitative manner; but, if there is electrolysis, we have a means of examining the behaviour of rare or of highly infusible bodies under the action of the electric current, for the arc, itself, may be at a far higher temperature than the pole without their melting. I find that the arc will not wet (in a capillary sense) carbon, so platinum, iron, or some other metal must be used.

There was one more effect which I noticed which is interesting in that it gives on a small scale the same appearance as the sun when observed with a spectroscope, it gives a continuous spectrum inter-

rupted by *dark* lines. I have only succeeded in seeing the sodium line reversed, and this with a small direct vision spectroscope. At first I was led to speculate on the possibility of the constituents of a liquid absorbing the same light as they would themselves give out, but the dark sodium line observed was probably due to an atmosphere of soda round the liquid arc, replenished by volatilisation from its surface.

I must apologise for bringing before the notice of the Physical Society a description of experiments so incomplete and disconnected, but as the subject is of such interest, and as my time is fully occupied in another direction, I hoped that some one more experienced, and more skilful than myself, would think it worth while to take the matter up.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

II.

THE SINGLE NEEDLE INSTRUMENT—*continued.*

REFERRING to fig. 2 in the last article, in order that other stations may be able to transmit signals through the instrument the arrangement of the tappers is such that when they are at rest the circuit between terminal B and terminal A through the dial is complete. The course of the current, supposing it to enter at B, in this case is as follows:—From terminal B the current passes through the dial to terminal T, thence through the left-hand hinge-block, P, and the tongue, *t*, to contact-block *k*, from there it passes to *k'* through the strap which connects the latter with *k*, which strap is secured by the thumb-screws, X and Y. From *k'* the current passes to the tongue *t'* and through the right-hand hinge-block to terminal A.

In tracing these connections it must be borne in mind that the block which supports the spring, *s*, *s'*, is not connected either with the blocks, *k*, *k'*, or with the strap which joins them, but is insulated therefrom.

"HIGHTON'S TAPPER."

Although the form of "tapper," or pedal key, described in the last article is the one most extensively used in the post office, yet an older pattern, designed several years ago by Mr. E. Highton, and extensively used by the "Magnetic" Company, is employed in a large number of cases.

This "tapper," which is shown in perspective by fig. 7, and in general plan by fig. 8, is very simple in design, a noticeable point being that only one movable spring is employed in its construction. There cannot be less than *one* movable spring, or its equivalent, in a key, and as every additional spring used not only renders the mechanism more complicated, but more liable to derangement, the less springs, of the kind, employed the better.

It will be seen from the figs. that the apparatus consists of two ebony pedals, E and F. These pedals are attached to a wooden block at the back of the base by flat brass springs, s^1, s^2, s^3, s^4, these springs take the place of the hinges in the tapper described in the first article. The springs on each pedal are insulated from each other, both on the ebony pedals and on the back wooden block to which they are screwed, but the left-hand spring of one pedal is connected with the left-hand spring of the other pedal by means of a brass strap, shown by *x*, fig. 7. Also the right-hand springs are similarly connected by means of a brass strap fixed to the inside of the wooden block. Both these connections are shown by the dotted lines in fig. 8.

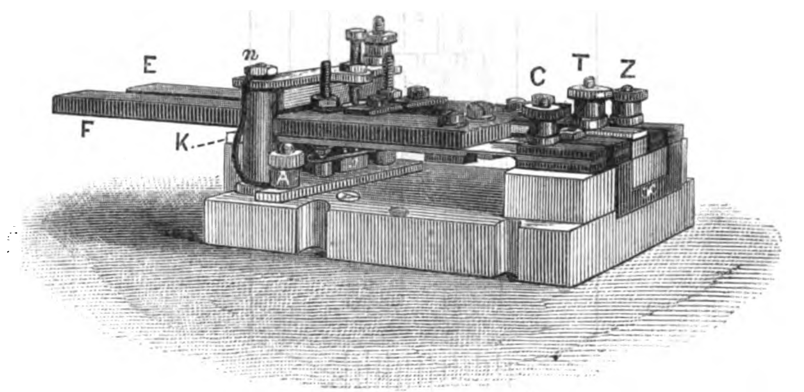


FIG. 7.

The right-hand spring, s^2, of the left-hand pedal is continued along underneath the latter, and is connected to the brass tongue, *t*, the lower part of which is faced with platinum. Similarly, the spring s^3 of the right-hand pedal is connected to the tongue t^1.

The left-hand spring, s^1, of the left-hand pedal is continued along under the latter, and is connected with the screw *b*, which passes through the pedal and makes contact, when the latter is depressed, with the end of the spring screwed to the brass block, *g*, fig. 7. Similarly, the spring, s^4, of the right-hand pedal is connected with the screw, *c*, which makes contact, when the pedal is depressed, with the right-hand end of the spring attached to

the before-mentioned block, *g*, fig. 7; the ends of this latter spring are bent up slightly, and when a pedal is depressed and contact is made by either of the screws *b* or *c*, they bank down upon small metal blocks placed underneath them, and both of which can be seen in fig. 7. The play thus given to the ends of the spring ensures a good rubbing contact being made.

The broad steel spring, s, fig. 8, is screwed to the back wooden block, and is provided with a terminal, T, which corresponds to the similar terminal in the other form of tapper (figs. 1 and 2, Art. I.). The portions of the spring immediately beneath the tongues, *t*, t^1, are faced with platinum. The further end of the spring normally makes contact with a screw, *a*, passing through the brass bridge H. The under part of this bridge is faced with leather, and against this the pedals normally rest.

pole of the battery being in communication with the spring, s^2, becomes connected by the medium of the latter, with the tongue, *t*, which is now in communication with the steel spring, s, the latter having been, by the depression of the pedal, pressed away from the contact screw, *a*; thus the pole in question becomes connected with terminal T, and thence through the dial of the instrument with terminal B and the "Down" line.

If the right-hand pedal be depressed, the zinc pole of the battery becomes connected with the terminal T and the "Down" line through the medium of the spring s^3, the tongue t^1, and the spring s. The copper pole, C, becomes connected through the spring, s^4, with the screw contact, *c*, and thence by the spring on the block, *g*, fig. 7, with terminal A and the "Up" line; thus the direction of the current is reversed.

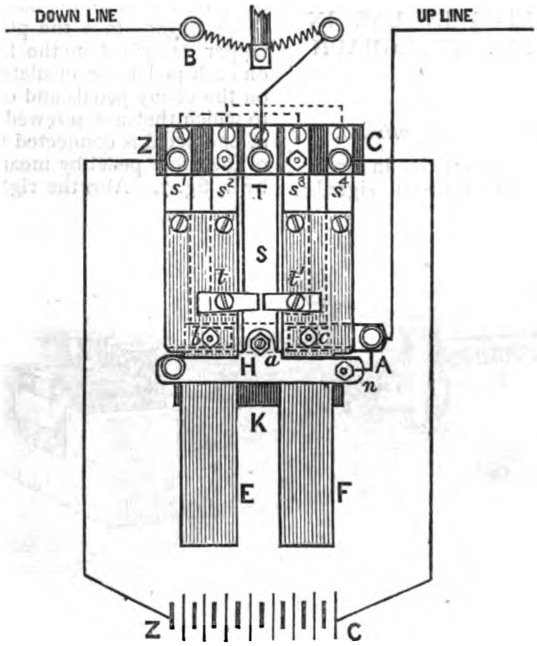


Fig. 8.

The brass block, *g*, fig. 7, to which is secured the contact spring, is itself attached to a brass plate fixed to the base of the apparatus, and has the terminal A secured to it.

To springs s^1 and s^4 are secured the terminals Z and C, which, together with terminals, A and T, correspond to similar terminals in the other form of tapper.

A block, K, faced with felt, is fixed under the front of the pedals.

Action of the tapper.

Supposing the left-hand pedal to be depressed, then the Zinc pole of the battery becomes connected to terminal A, through the medium of the spring, s^1, the screw, *b*, and the spring attached to the block, *g*, fig. 7, which latter block, as was before pointed out, is connected to A. The Zinc pole is thus connected to the "Up" line. The Copper

When signals are being received on the instrument from another station, then the course of the current will be, say, from terminal B, through the dial to terminal T, thence through the spring, s, to contact screw, *a*, and the bridge, H; from there the current passes to terminal A, through a connecting piece of wire which joins A with the nut, *n*.

As compared with the other form of tapper, the Highton keys are simpler in construction, but the springs, s^1, s^2, s^3, s^4, are liable to break, whereas the hinges, P, P (figs. 1 and 2, Art. I.), cannot well get out of order. If, however, good metal is used, these keys will last for a very long time; indeed, cases are known in which the wood of the pedals, E, F, has actually become worn, from constant use, to the shape of the fingers that have grasped them, and yet the brass springs and contacts have remained perfectly good.

The general appearance of the single needle instrument, when ready for use, is shown by fig. 9. The case which covers the working parts can be removed when necessary by unscrewing two thumb-screws, one on each side.

The desk which is used for supporting the message-forms projects immediately beneath the dial face; it is provided with a small hook at its upper part, on which the form can be secured from slipping down, if necessary.

The brass frame screwed to the lower part of the right-hand side of the case is for the purpose of holding a card on which are printed the names and "codes" of the stations in circuit with the instrument.

It will be noticed that there are no terminals external to the instrument, but that every wire is boxed in. The wires from the terminals inside, in fact, all pass direct through the base of the instrument to the batteries and the line wires; this is advantageous, as it prevents "disconnections" being caused by wires being knocked off from dusting—a contingency which is very likely to occur in small offices, if precautions are not taken to avoid it.

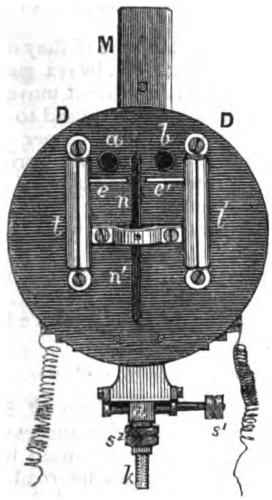


FIG. 10.

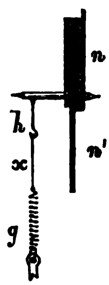


FIG. 13.

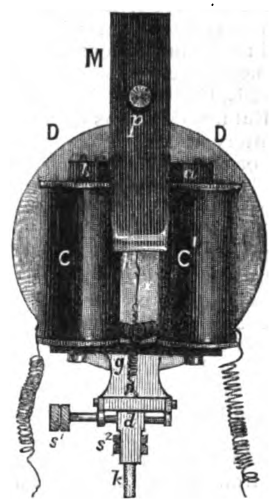


FIG. 11.

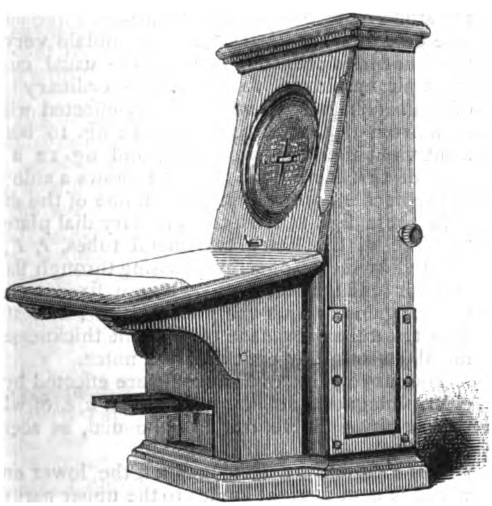


FIG. 9.

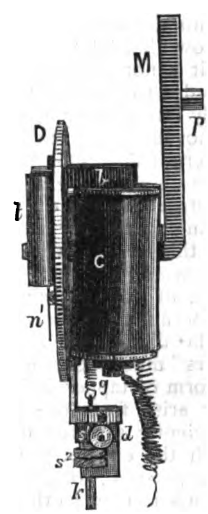


FIG. 12.

Faults.

The "faults" to which single needle instruments are liable are not numerous, nor, as a rule, are they difficult to detect.

A fault which interrupts the working of the apparatus may either be on the "Line," in the "Battery," in the "Dial," or in the "Tappers."

The first kind of fault may be detected by connecting terminals A and B by a piece of wire, and working the pedals; if the needle responds energetically, it may be taken for granted that the fault is external to the instrument and battery. If, however, the needle responds but feebly to the action of the pedals, the probability is that the battery is in fault. But if no signal is observed on the needle, and the battery on inspection appears to be in good condition, or is proved to be so by connecting a "detector" galvanometer to it, then the fault will prove to be in the "Dial" or "Tappers."

It will be noticed, from fig. 2 in the last article, that four terminals are provided in connection with the Dial part of the instrument; to the two upper ones the coil wires of the dial are directly connected, as are also the two upper wires of the lightning protector, *l*. The two lower terminals have the two lower ends of the protector wires connected to them, together with the "Down" line wire and terminal T. Now, a probable fault in the dial is "contact" in the lightning protector, *l*. To ascertain whether this exists, disconnect the line wire from B, and then touch the latter with one battery wire, and also touch the corresponding terminal on the right-hand side of the protector with the other battery wire; if no movement of the needle takes place, then disconnect one of the upper wires of the protector from the terminal to which it is attached, and touch the two upper terminals with the battery wires. If the needle is now affected, then the fault is in the protector; if it is not affected, then the fault is in the dial. In order to prevent the latter kind of fault from totally interrupting the other stations in the circuit, a movable brass bar is connected to the top left-hand terminal. This bar is normally left in the position shown in fig. 2, but by raising it so as to connect its free end to the top left-hand terminal, and screwing it to the latter, the dial is short-circuited; this enables the other stations in the circuit to work without interruption, the line connections, of course, being connected to their respective terminals. Should the fault not prove to be in the dial or the lightning protector, then the "tappers" must occasion the interruption.

In the form of tapper indicated by figs. 1 and 2 faults may arise from the screws at *f* and *g* not being sufficiently screwed down to make proper contact with the ends of the spring, *v*, *v'*, when a tapper is depressed; or from these screws being screwed down too far, so that the tongues, *t*, *t'*, do not make contact with the ends of the spring, *s*, *s'*; this latter fault may arise from the ends, *s*, *s'*, having become bent up. Lastly, the springs, *n*, fig. 2, underneath the tappers, may have become broken.

The faults in the form of tapper shown by figs. 7 and 8 may be due to the screw contacts, *b* and *c*, being screwed down too far, so that they touch the contacts underneath them before the tongues, *t*, *t'*, fairly move the spring, S, away from its contact with the screw, *a*. It occasionally happens that from constant use the springs, s^1, s^2, s^3, s^4, become weak and fail to raise the pedals, E, F, fairly up against the bridge, H, but allow the tongues, *t*, *t'*, to rest on the spring, S. The springs occasionally break, but, of course, such a fault is evident at once.

Faults occasionally occur in both forms of tappers from dirty contacts; but these faults are very rare, as the mechanical action of the tapper, and the jars occasioned by their use are usually quite sufficient to dislodge any dust or dirt which may have accumulated on the platinum points.

Intermittent faults in the tappers, if they occur, are very troublesome, and must be always guarded against by seeing that there is a distinct movement in the springs or parts which are required to have play; for instance, in the Highton tapper there must be a very decided movement of the spring, S, away from the contact screw, *a*, when a pedal is depressed. A slight movement of S *may* be all that is necessary when the tappers are first worked, but the natural wear which occurs is almost certain sooner or later, in such a case, to cause this movement to fail altogether, and thus cause a fault.

Over 3,500 single needle instruments are in use in the postal service.

"NEALE'S ACOUSTIC DIAL."

Within the last two years a new form of Single Needle Dial has been introduced with success into some of the single needle instruments used by the Post Office. This arrangement can be read from, either like an ordinary single needle dial, or by means of the ear.

It has often been the practice of highly-skilled clerks to read from the "click" of the needles against the ivory stops, and in many cases the sound has been augmented by attaching barrel pens to the studs, or by home-made devices of a like nature. The object of the Neale dial is to obtain very distinct and decided sounds with the usual current strength employed to work the ordinary form of dial. The way in which this is effected will be seen from figs. 10, 11, 12, and 13; fig. 10 being a front view, fig. 11 a back view, and fig. 12 a side view of this invention. Fig. 13 shows a side view of the needle removed from the frame of the dial.

In these figs. D, D is the ordinary dial plate; to the face of the latter two metal tubes, *t*, *t'*, are secured by means of screws passing through flanges at their end; metal pins, *e*, *e'*, are fixed to these tubes, against which the needle, *n*, *n'*, can strike. The two tubes are made of different thicknesses of metal, so that they emit different notes.

The movements of the needle are effected by the electro-magnet, C, C', the pole pieces, *a*, *b*, of which, project through the front of the dial, as seen by fig. 10.

M is a permanent steel magnet, the lower end of which is bent at right angles to the upper part; this end passes a short distance through the face of the dial, and is in close proximity to the lower end of the upper part, *n*, of the indicating needle. The back part of *n*, fig 13, is formed of a broad piece of soft iron (shown by the shaded portion) through which the axle of the needle passes. This piece of iron becomes magnetised by the inductive action of the permanent magnet, consequently the upper part of *n* is attracted and repelled by the pole pieces, *a*, *b*, in one direction or the other, according to the

direction of the current, and thus the whole needle can be deflected to one side or the other, against the stop pins, e, e^1.

In order to keep the needle normally in a vertical position, its axis has a small hook, k (figs. 11 and 13), fixed at right angles to it; to this hook, and also to one end of the spiral spring, g, a piece of silk thread, x, is fastened; the other end of the spring is attached to a screw, b, which passes through the piece, d, and can be raised or lowered by means of the thumbscrew, s^2. By screwing s^2 round in one direction or the other it is evident that the tension of the spring, g, can be increased or lessened, and consequently the tendency of the needle, n, n^1, to come back to the vertical position be increased or diminished as required.

The piece, d, and with it the thumbscrew, s^2, and the screw, k, can be moved to the right or left by means of the thumbscrew, s^1; by the adjustment of the latter, therefore, any tendency of the needle to hang over to one side or the other from the true vertical position can easily be corrected.

The magnet, M, which has a stop-pin, p, is similar in shape and position to the brass piece, A, A (figs. 3 and 4, Art. I.) of the ordinary dial, consequently the whole arrangement can be fitted at once into any of the cases of the complete single needle instruments.

The coils, C, C^1, are wound to a total resistance of about 200 ohms, and when carefully adjusted the needle can be deflected up to the stops, e, e^1, if a current of 3·3 milliwebers (see end of Art. I.) traverses the coils, there being sufficient tension given to the spring, g, to bring the needle back to zero when the current ceases to flow. For working purposes a current of about 5 milliwebers would be required.

The advantage of the "acoustic" over the ordinary dial is that it leaves the eyes at liberty to see what is being written down on the message-form.

ERRATA.—In Art. I., page 23, first column, at the end of the sixth paragraph, *for* "a curved brass spring, n, shown in fig. 2," *read* "a curved brass spring, n, shown in fig. 1."

On the same page, second column, at the end of the first paragraph, *for* "If the instrument is at a 'Down' station, the terminal A must be put to line and terminal A to earth," *read* "If the instrument is at a 'Down' station, the terminal A must be put to line and terminal B to earth."

On page 25, first column, at the end of the third paragraph, *for* "1 Daniell cell flowing through a total resistance in the circuit of 3,000 ohms, that is to say, a current of $\frac{1}{3000}$ webers, or $\frac{1}{3}$ milliwebers," *read* "10 Daniell cells flowing through a total resistance in the circuit of 3,000 ohms, that is to say, a current of $\frac{10}{3000}$ webers, or 3·3 milliwebers."

A SYSTEM OF ELECTRICAL STORAGE.

IN a paper recently published in the *Journal of the Franklin Institute* Professors Edwin J. Houston and Elihu Thomson have described a system of "Electrical storage" devised by them :—"The various suggestions which have hitherto been made for the storage of electrical energy, in such manner as to readily permit its after recovery in the form of electrical current, have failed when attempted to be carried into practice, either on account of their inherent impracticability, or by reason of the serious inconveniences and losses due chiefly to the following :—

"1st. The extent of conducting surface of the storage apparatus required to be acted on, rendering it cumbrous.

"2nd. The loss of energy due to evolution of gas during the operation of charging.

"3rd. Lack of constancy and duration in the currents evolved after charging.

"4th. The limited capacity for storage due to the proportion of active material being but a fraction of that present.

"The well-known Secondary battery of Planté lacks the requisites of an economical reservoir for electrical action. In the secondary battery the duration of action is chiefly dependent upon the amount of surface of the lead plates employed, and the charge received is necessarily limited on account of the evolution of gas.

"In the system of electrical storage devised, the duration of action and consequent capacity for storage is independent of extent of surface and dependent on the mass of material to be acted upon. In this method a saturated solution of zinc sulphate, enclosed in a suitable vessel, at the bottom of which is placed a plate of copper, to which is connected an insulated conducting wire, are employed. At or near the top of the vessel, and immersed in the solution contained therein, is placed a second copper plate, or plate of hard carbon, or metal unchanged by contact with zinc sulphate solution, and less positive than metallic zinc. This is also connected to a wire. The storage cell so constituted is then ready for charging, which is effected by the passage through the cell of a current, whose direction is from the lower to the upper plate. The current employed is that obtained from a dynamo-electric machine, and the result produced is the deposition of metallic zinc on the upper plate and the formation of a dense solution of copper sulphate overlying the under plate. The duration of the charging action is of course limited only by the amount of zinc sulphate and the thickness of the lower plate. The cell, after charging, constitutes in fact a gravity cell, and continues a source of electrical current until a reconversion of all the copper sulphate into zinc sulphate has been effected, metallic copper being deposited on the lower plate, and the deposit of metallic zinc being removed from the upper. It thus may be allowed to regain its original condition. The re-charging, however, may be effected at any time, either before or after the cell has become inactive. The cell may be covered or sealed to prevent evaporation; and since no addition of new material is needed, a restoration to an active condition is at any time possible.

"A, fig 1, represents a cell of glass, or other suitable material, furnished with two metallic plates, B and C, connected separately by conducting wires to the terminals, b and c, the wire from the lower plate being insulated. A porous diaphragm, E, is placed before the upper plate, C, to prevent fragments of deposited zinc from falling on the lower plate, which may occur should the charging current be too intense.

"In charging, the arrangement of the cells in

multiple arc or in series may be adapted to suit the electro-motive force of the dynamo-electric machine employed. The arrangement of the cells in charging may be different from that in discharging, according to the purpose for which the current is designed. Diffusive action of the solutions may be prevented by any of the well-known means used in gravity cells.

"It may be objected that the economical results obtained in the storage of electricity as above-described will necessarily be low, as but a fraction of the electrical energy in charging will be expended in overcoming counter electro-motive force, or in effecting electrolysis, compared with that which overcomes the resistance of the liquid, and therefore lost in heat-production. But this objection is readily met by so connecting the cells as to make their counter action or counter electro-motive force the chief resistance to its passage. Economical results necessarily follow, the economy attained being measured by the relative cost of the fuel required to drive the dynamo-electric machine and that of the zinc and chemicals used for charging a battery of equal power to that of the storage battery used.

FIG. 1

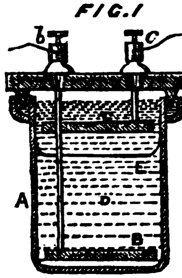
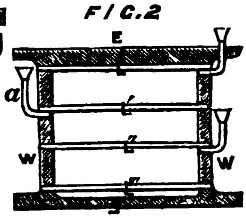


FIG. 2



In charging, economical results are obtained by using the plates comparatively near to each other, and separating them during discharge, and thereby avoiding loss by diffusion.

A convenient form of storage battery, designed for rapid charging and discharging, is shown in fig. 2, where L, L′, L″, L‴ are horizontal plates of copper separated by insulating rings, W, W, the spaces between the plates, L, L′, &c., being filled with a saturated solution of zinc sulphate. Lateral tubes, *a*, are provided to compensate for the expansion of the liquid due to changes of temperature, and also to provide for filling the cells. The cells are held between plates, E E, by bolts which pass from one to the other. In this arrangement, the plates L′ and L″ serve as upper and lower plates, accumulating copper sulphate on their upper surfaces and receiving metallic zinc on their under surfaces. This series may of course be extended. When a number of cells are connected in series, several of them may be charging, while the remainder are used as a source of active current.

The most obvious application of a storage battery furnishing a constant and lasting current, is to replace the ordinary telegraphic batteries. In lighthouses, a dynamo-electric machine can be run by suitable power at intervals during the day to furnish an unfailing and reliable source of current for lighting purposes."

Mr. C. F. Varley employed a storage battery to distribute time signals through the telegraph system of Great Britain and Ireland. This battery (which is no longer in use, as Leclanché cells of large dimensions are found to answer the required purpose in a more satisfactory manner) consisted of gutta-percha chambers 4½ inches high, each with a division in the centre 1¼ inches deep; the shallow cells so formed were half filled with mercury, and into these mercury cells carbon plates dipped. The mercury in one cell was metallically connected with the mercury in the contiguous cell of the neighbouring chamber; the last carbons of the set of chambers were connected with terminals, to which the charging and discharging wires were attached. The cells being charged with sulphate of zinc and sulphuric acid, on sending a charging current through the set of cells amalgamated zinc became formed on one carbon in a cell, whilst oxygen formed on the other carbon, and bisulphate of mercury on the mercury in which the latter carbon dipped. Sixty cells of this battery, when charged by 150 small Daniell cells, gave a powerful current, the duration of which depended upon the time the charging battery was kept on. The arrangement having a very low resistance, could give a strong current upon a large number of lines at one time. This, in fact, was the object of the battery.

CODES AND CODES.

If any proof were required that human ingenuity has no yet reached its utmost development, it would, we think, be found in the activity existing in the matter of Code making.

After some little contest with the public, first, as to the admissibility of coded messages, and afterwards as to the restrictions that should be imposed upon them, the Telegraph Companies finally recognised the necessity for coding in order to ensure secrecy, and also with a view to promote telegraphing on transactions that would not pay for a large outlay. With a large liberality the length of code words was fixed at seven syllables, as it was expected that code words would fairly alternate with shorter words in plain language. But it was very soon discovered that telegraphers, when code words failed, were accustomed to string together several words or parts of words in one: thus, when short-sightedness had failed to provide for the acknowledgment of a telegram despatched the previous day, such words as "Yestelred" were made up from parts of the words, *Yesterday's telegram received.*

This style of coding was most extensively resorted to by merchants of the lower grade, whose intelligence was not equal to code making. It was however frequently adopted by the larger firms when they found their codes at fault. It was therefore discovered that the words in coded messages, which at the lowest computation might be considered as representing five times the number of words paid for, were as a rule from two to three times the average length of words in plain language messages. Hence the reduction in the number of letters permitted in code words as per St. Petersburgh Convention Rules.

No change was then made in the rating of figure groups, as up to 1875 figures were not largely employed for coding purposes, and groups of two or three figures were as often sent as groups of four or five, but in order to prevent the use of figure cyphers the rule as to the rating of figures was coupled with the proviso that figure groups should be permitted to notify quotations only; but here again it was found that figure groups were as often sent to convey a secret meaning as to express a quotation, and as in the former case they consisted entirely of groups of five figures, the average number of figures per group rapidly approached the maximum number allowed. The Telegraph Companies have decided to remove all temptations to misrepresentation as to the meaning of figure groups by limiting them *to three* per word and permitting them to have a secret meaning.

This limitation will weigh heavily on a certain class of

telegraphers, and will render the employment of codes necessary even by those that have hitherto confined themselves to plain language messages, inasmuch as such quotations as "6¼," "3½," &c., will be reckoned as two words.

Hence the activity in the matter of code making which suggested our opening remark.

We have ourselves ample evidence of this activity, for we have had no less than seven codes sent to us for review, and have heard of several more.

Three of the former have thought fit to accompany their books with the intimation that a handsome douceur would follow a favourable critique. Not caring to air our wounded feelings, and having a very wholesome respect for the law of libel, we simply tell these gentlemen that we deal with facts as we find them. Of the codes sent us we shall speak generally, for we can only describe these codes, with one exception, as traps for telegraphic errors.

One author "begs to assure us that his code words have been telegraphically examined, and that a code which he made for his employers was used without a single telegraphic error that occasioned any inconvenience during the four years it was in use." If this statement be true, it certainly speaks volumes for the correct working of the telegraph companies, for on the first page opened by us we found the code word "Agnatio" followed by the word "Agnatum," and "Agnolen" followed by "Agnolete." Further on we observed the words "Impie" and "Imps," and still further on we found the words "Label," "Labelled," "Labelling," not far from "Libel," "Libelled," "Libelling." We instance these words not as the only examples we found, but because in the three former pairs of words the first sentence represents an affirmative, and the latter a negative.

To us it appears perfectly impossible that the author can have the slightest knowledge of telegraphy, or he would have seen that such words as "Agnatio" and "Agnatum" are far more mischievous than words with only one letter difference, as they are identical in the signals employed, the only difference being in the *spacing*. To employ such code words to represent, the one an affirmative and the other a negative, sentence, we regard as an evidence of the greatest recklessness or ignorance. We lately heard of a code maker who called at an office of one of the principal telegraph companies, and requested to be supplied with a copy of the telegraph signals, naively adding that he had published a telegraphic code, and wished to be able to say that it had been *telegraphically examined.*

As a further proof of the activity existing in the matter of code making, we may state that we have lately heard with surprise that even some of the officials of the telegraph companies are engaged in the work, apparently influenced by the idea that if anything is to be got out of it they may just as well have it as any one else.

Here is a specimen of some words from a list of code words compiled by one of them and his assistants:—"Bird," "Bind," "Bedizen," "Bedewer," "Branding," "Bracing," all of which are different by a dot only, and occur on one page.

There is an old Latin proverb which this official might bear in mind, *Ne sutor ultra crepidam.*

For the public this last freak of telegraph officialism is perhaps a subject for congratulation, for if such words as "Bind" and "Bird" be considered safe words, and exist in the same code, there can be but little excuse if the telegraph companies make mistakes in words where the difference is much greater.

In another code we observed greater difference. Its author had adopted long words. Of fifty words on one page, thirty-seven consisted of ten letters, and eight consisted of nine letters. Of the thirty-seven words, three were Italian words, and ended in "iam," whereas these words, if properly spelt, would have ended in "iamo," and would, therefore, have contained eleven letters. Others ended in "in" instead of "ino," or "ar" instead of "are;" the final letter in each case being dropped for the same reason." We hardly think that after these remarks the authors of these codes will blame us for concealing their names.

Another form of code, or to speak more correctly, another form of code word vocabulary, has lately appeared in the form of "Termination Codes."

The compiler selects a certain number of the most suitable stems of verbs (or "roots," as one author calls them), and then chooses ten or more endings to be attached to each.

Thus 10,000 verb stems, with ten endings for each, will form 100,000 words. The chief advantage of this system is its compendiousness. It is not, we think, free from objections, inasmuch as it restricts the words available for coding purposes to regular verbs only, and ignores the variations to be found in irregular verbs and the other parts of speech. We hardly think that telegraphers would have regarded such a limitation as anything but extremely arbitrary if it had been enforced by the telegraph companies. Irregular verbs appear to us worthy of special *attention*, from the fact that their irregularity often provides the very difference in the words which it is so desirable to obtain. To ignore them may, and doubtless does, largely reduce the labour of selecting a certain number of code words, but it appears to us manifest that a carefully compiled list of code words selected from every part of speech, and every form of verb, and word must, in the main, be safer than a list of words selected on the termination, or *mechanical* principle.

Words with only a letter difference, or worse still, words with similar telegraphic signals, will escape the keenest observation; but it will not fail to be noticed that such weaknesses are generally multiplied in a mechanical code tenfold if the error occur in the stem, or a hundred or perhaps a thousandfold if the error occur in the ending.

Thus in the almost contiguous stems "Accan" and "Accatt," on the first page of one of these codes, the sole difference, besides the spacing, is between a dot and a dash, and as these stems are provided with six endings common to both, the error is multiplied by six.

Again, in the stems "Acafel" and "Acall," apart from the spacing, there is only the difference of a single dot. Yet these stems, though belonging to different languages, have five common endings.

The stems "Atigr" and "Emigr" are perfectly identical so far as signals are concerned, and are provided with one common ending, "ais," whilst another ending in one is "Ames," and for the other, "Amos."

The stems "Arel" and "Arf"—spacing apart—differ but by a single dot, and are provided with eight common endings. The stems "Cisc" and "Trisec" again differ, but by a single dot, and are provided with ten common endings. The same may be said of the stems "Conche" and "Tronch." It is not necessary to pursue this subject farther, but we may add that we have referred to a part only of the weaknesses we observed in a very cursory and hasty examination of the work.

With respect to the kind of stems selected we have little to say, but we cannot but regard the adoption of Italian stems, commencing in "Sb, Sd, Sf, Sg, Sr, and Sv," as open to grave objection. Being strange to the greater number of telegraph operators the initial letter of such words is liable to be detached and appear as the final letter of the preceding word. If an accident of this kind happen to such stems as "Sdebit, Sdent, Sdonn, Sfoll, Sgorg, Svolg," the remaining part of the stem might in some cases, where the endings are similar, and would certainly in other cases where the endings are identical, be mistaken for the stems, "Debett, Dente, Donne, Foli, Gorge, and Volig." In the endings we note that the author makes use of "enclitics;" ten of his sixty Latin endings being compounded of the hort terminations, "o, e, io," &c., with the conjunctions, "que, ne, ve;" and we further note that the author soundly rates a critic who, in reviewing this work in the columns of a contemporary, questions his right to do so, and states that such words as "Abdicoque" are in reality two words.

The author says that he has no doubt about the matter. We can say the same. We have no doubt whatever about the matter, but our opinion is opposed to his, for having enjoyed the benefit of an excellent classical tutor we remember well that we had to parse the conjunction apart from the verb. "What!" he would say, if we omitted to parse the conjunction as well as the verb, "Do you think that word is there for the flies?"

We have accorded to this author a somewhat longer notice than we have given to the others, as we note that the circular, issued to announce the publication of his work, largely consists of no very kindly criticisms on the efforts of others. We have endeavoured to avoid the harsh language in which he so freely indulges. He cannot be ignorant of the difficulties in the way of selecting so large a number of good and safe code words as 100,000. He appears to be conscious

that he has not entirely succeeded in getting a perfect selection in his 50,000, although he had but 5,000 stems to select. At least, we interpret the last paragraph in his introductory remarks to mean this, for he there invites purchasers to leave their names and addresses with the publisher, so that any corrections or improvements may be notified to them, requesting also to be informed of any errors in printing, &c., that may be detected in practice.

For ourselves we believe that it is impossible to exaggerate the difficulties in the way of the successful accomplishment of such a task; and by way of giving point to our remark, rather than with a desire to criticise this author's efforts further, we give one more example before we dismiss the subject. The two stems "Anonn" and "Ponte" are, as to telegraphic signals, perfectly identical, as a n=p and n=te. The stem "Anorte" that follows "Anonn" differs from both as to signals by only a single dot, the first dot of the letter r; but although these words belong to a different language, yet the identity in some of the endings ("ais" being found in both French and Spanish, and "amos" "ando," "aria," "ais," and "o," in Spanish and Portuguese) provides six pairs of words, in one of which no difference whatever exists in the signals, and in the other five the difference is only a single dot.

We hope to offer some remarks on "Codes and Coding" in an early issue.

Notes.

An accident of an extraordinary nature occurred recently at the Holte Theatre, Aston, near Birmingham. The stage was lighted by two electric lights, and when the candles were not burning two brass connections used for the purpose of crossing the current were hung up over the orchestra. After the performance of the pantomime Mr. Bruno, the euphonium player, was leaving with the other members of the band, when, presumably out of curiosity, he caught hold of the two brass connections referred to. The man in charge called out to him, with the object of warning him of the danger he was incurring. The caution, however, came too late. Mr. Bruno received the full shock of the electric current, generated by the powerful battery which supplies the whole of the lamps in the building and grounds. The shock rendered him insensible. A medical man was at once sent for and restoratives were applied, but Mr. Bruno died in about 40 minutes afterwards. If the connecting wires had been insulated in the usual way it is evident that the accident would not have occurred.

M. W. de Fonvielle writes to a contemporary that: "M. Denayrouze, the former lessee of the Jablochkoff candle, has purchased the Jamin candle, in which the electric flame is directed by the attractive power of magnetism or electricity. Private experiments have been made, and they are preparing for an exhibition in one of the suburbs of Paris. M. Jamin having to lecture at the Sorbonne on January 17th it is probable that the large hall will be illuminated by his own light on this occasion. This light company has purchased a patent for gas engines, and will try to use the gas under the furnace as fuel, dispensing with it for illumination. They are said to contemplate a public issue of shares for a large capital." Also, he says, the Messrs. Siemens' agents "are at present fitting a large factory at Meaux with their regulators and generators."

Mr. Dalman of Barcelona (Spain), well known as the introducer of electric light in that country, has just established a light in his show room, at some distance from his works. A conductor 560 mètres in length connects the lamp to the Gramme machine. Only one conductor is used, as the earth is used instead of a return wire. This, we believe, is the first instance of the electric light being used at such a distance from the generator with only one conductor. In London it is contemplated to use the rails of the permanent way on the Metropolitan Railway in the place of a return wire, when the contemplated extension of the Jablochkoff system, already in existence, is carried out.

The reports of the success of Edison's new electric light at his Menlo Park laboratory have had the effect of advancing considerably the price of shares in the Edison Electric Light Company. The total capital stock of the company is 300,000 dols., in 3,000 shares at 100 dols. each, and the company controls the right for the entire United States. Within ten days the shares were quoted at 1,000 dols. each; the next recorded sales were one share for 2,500 dols.; two shares sold for 3,300 dols., and another share for 3,500 dols. Holders of the stock are now asking 5,000 per share. —*Railway News.*

On Wednesday, the 7th of January, for the first time, except for the sake of experiment, six Jablochkoff electric lights were used around the stately mansion of the Marquis of Salisbury, at Hatfield, the occasion being a grand ball. The effect is described as simply marvellous, the whole vicinity of the mansion being lighted up as if by daylight.

Mr. David Flannery, an assistant superintendent of the Western Union Telegraph Company in Mississippi, has recently discovered a new method of dividing the electric current for illuminating purposes. His claims have all been allowed and recognised in the Patent Office at Washington.

The German Telegraph Engineers have reported favourably on the alloy of alminium and iron; it produces a wire both finer and stronger than iron wire, less susceptible to atmospheric changes, and superior as a conducting medium.

The Merchants' Telephone Exchange in New York has upwards of 600 wires entering its central station. The Edison telephone is used, and more than 1,000 battery cells are required for working the same.

The telephone is now used on the South Eastern Railway to facilitate conversation between the station-masters at Charing Cross and Cannon Street stations. Gower's improved Bell is the instrument mentioned.

Gower's Telephone.—A company has commenced operations at Gresham House, Old Broad-street, to work the Gower patent telephone, using it in conjunction with a carbon transmitter. All kinds of telephonic business are undertaken by this company, except that on the exchange or central system.

Crossley's patent microphonic telephone transmitter seems to be used extensively and with great success. Amongst other places we may mention that the Lancashire and Yorkshire Railway Signal Cabins are fitted with it, and also the depots of the Leeds Tramways Company. The Post Office authorities have adopted this form of telephone for use in connection with their private wire system.

The Post Office and the Telephone.—On January 20, in the High Court of Justice, before the Lord Chief Baron and Mr. Justice Lopes, an infor-

mation filed in the Exchequer Division by the Attorney General against the "Telephone Company" for a breach of the Post Office Telegraph Act was mentioned:—The Attorney-General said he wished to mention this case, but not to make a motion in it. He had filed an information against the company with the view of restraining them from using certain wires, which the Postmaster-General said were telegraph wires, and of which that Minister had a monopoly, which he had purchased at an enormous sum. He had been instructed to move for an interim injunction against the company, but he was happy to say they had made the following arrangement. The company had agreed with the Postmaster-General to the effect that the motion in the case should be postponed until a day subsequently to be appointed for the hearing. Affidavits in reply were to be furnished by the company on or before January 27, and the Postmaster-General would have 10 days to reply to them. The case would then be brought on as soon as their lordships would be able to fix a day. The information had been filed in the Exchequer Division. In the meantime the company had agreed to keep an account of the number of telegraph messages they sent out and the earnings they made.

Mr. Macrory represented the company, but was not present, as he understood the arrangement had been agreed to.

Their lordships granted the application for the postponement of the motion accordingly.

In the same court an information against the "Edison Telephone Company" was also mentioned:—The Attorney-General said he was instructed in this case, with Mr. Kay, Q.C., Mr. Simpson and Mr. Karslake, to move their lordships for an interim injunction to restrain the company from carrying on their business in telegraphy. An information had been filed by him in this court, supported by affidavits by the Postmaster-General. From those affidavits it appeared that the company used the telegraph wire for sending messages throughout London for the purposes of reward, and the Postmaster-General said they were telegraph wires within the meaning of the Acts of 1863, 1868, and 1869, and that the use of them by means of the telephone was an infringement of the statute. He asked for an interim injunction to last until the hearing of the cause, but he would be quite ready, with the consent of his learned friend who appeared on behalf of the company, that the same arrangement should be made in the present as had been agreed to in the former case.

Mr. Cozens Hardy, on behalf of the company, said his clients were very anxious that the motion should be disposed of as soon as possible. His affidavits would be filed by Thursday next, when the motion could be disposed of.

The Lord Chief Baron inquired of the Attorney-General whether he asked that the motion should be considered now or that the motion should be postponed?

The Attorney-General replied that he would be quite willing that the latter course should be adopted if, in the meantime, the company would keep an account of the messages sent by their wires. The Postmaster-General wished to reply to the affidavits which would be filed by the company.

Mr. Cozens Hardy said his clients were quite ready to keep an account of their receipts and expenditure, but he was instructed that they had no means of keeping such an account as the Attorney-General had mentioned.

The Attorney-General said the account required was of the following nature. Supposing a person in Brompton wished to send a message to a person in Broad-street by means of the telephone, the former would request the authorities at the central office to connect him with the office at Broad-street. The connection was made, and the two persons carried on a conversation as long as they liked. All that was required was that an account should be kept of the number of times a connection was made.

Mr. Cozens Hardy said his clients instructed him they had no means of doing so.

The Lord Chief Baron said it must be possible to keep such an account without the slightest difficulty. It was to the advantage of the company to accede to the application. The Attorney-General had a perfect right at any time to come into court and obtain the postponement of a motion whether it was opposed or not.

Mr. Cozens Hardy then agreed to speak with the Attorney-General and arrange with him for the motion to stand over upon the conditions mentioned.

The motion was postponed accordingly.

In a recent paper to the Vienna Academy, by Prof. Exner, on the theory of inconstant galvanic elements, proof is offered that there is no so-called galvanic polarisation in elements, but that the phenomena referred thereto are attributable to the oxygen dissolved in water. The electromotive force of an element with only one liquid appears accordingly as a constant which is in no way affected by any polarisation of the negative pole. It is further shown that the force of a Smee element is not altered when its platinum is replaced by some other metal, provided only this do not itself give rise to chemical processes.

The German Postmaster-General, Herr Stephan, and Dr. Siemens, have succeeded in constituting an electro-technical society, which has for its objects the furtherance and development of the technical application of electricity, the progress of the knowledge of electricity by means of its technical appliances, and the establishment of a place of meeting for German technical electricians, whose scientific and commercial interests will, of course, be greatly benefited by such mutual intercourse.

Iron of January 23rd, in speaking of the Post Office and the telephone companies, says:—"The Telephone Company, *which does not employ electricity at all in transmitting its messages*, ought at least to occupy safe ground." [The italics are ours.—Ed. T. J.]

Mac Mahon Telegraphic News Co. (Limited).—This company has been registered with a capital of £25,000, in shares of £10, and to adopt and carry into effect an agreement, and is to erect and work between any office, residential club, place of business, &c., wires and apparatus for transmitting news. The subscribers (who take one share each) are:—T. E. Mac Mahon, Shepherd's Bush; J. Peacock, Hammersmith; J. B. Amor, Circus-road; L. Lumley, 20, Montague-place; R. K. Clay, Dublin; S. Sharpe, 12, Devonshire-place, and T. Sharpe, 41, St. James's-street.

Iron and Steel Wire.—Messrs. T. and L. Jenkins announce that their prices for all kinds of iron and steel wires are again advanced 1s. 6d. per cwt., or 10d. per bundle, upon price list dated October 25th, 1879.

Balmain's Luminous Paint.—*Engineering* says: "The Lords of the Admiralty have been making experiments with it in a darkened room at Whitehall, and have expressed themselves in favour of it for lighting

up the compartments of ironclads, or for the powder magazines; and two compartments of H.M.S. *Comus* have been ordered to be painted with it. For life-belts and buoys, it will of course be an acquisition in rendering them visible by night. A lantern capable of enabling a person to read or work in the dark can be made by framing a few square feet of painted surface; and the superintendent of the West India Docks has ordered lanterns for use in their dangerous spirit vaults. The virtues of these lanterns in explosive mines, petroleum stores, and cellars, are too obvious to be dwelt upon. Mr. Towers, who has just supplied the German Navy with his speed indicators, and is now engaged in adapting them also to several English war vessels, notably H.M.S. *Northampton*, has decided to have the dials of his apparatus illuminated in this way so as to enable seamen on the darkest night to read the index. Mr. Hollingshead, the enterprising manager of the Gaiety Theatre, is in treaty to secure the sole right to apply the paint in the production of theatrical effects; and it is probable that the process will soon come into conspicuous use as a medium for advertisements.

Proceedings of Societies.

PHYSICAL SOCIETY.—JANUARY 24TH, 1880.

Prof. W. G. ADAMS in the chair.

New Member.—Mr. W. ELLIS.

Mr. GRANT read a paper and exhibited experiments on "Induction in Telephonic Circuits." He was led to these experiments by a former observation. When an induction coil primary was placed in a circuit consisting of a telephone, microphone, and battery, the microphonic sounds heard in the telephone were increased on closing the secondary circuits of the coil. Employing a double wound coil—that is, one having primary and secondary side by side—he found that the latter could act as a condenser, and "relay" or translate messages into a second circuit, the microphone and battery being in the circuit of one wire (*i.e.*, the primary and the other wire or secondary containing a telephone). He also inserted a double wound coil in the latter or secondary circuit, and caused the induced or translated current to flow through both the wires of this double coil one after the other, in the same direction. The effect was weak; but on reversing the current in one half of the double coil, by means of a commutator, so as to make it double on itself, as it were, the weakening effect of induction was neutralised and the sounds heard were as loud as if no coil had been inserted in the secondary circuit at all, as was proved by short-circuiting the double coil altogether.

Dr. O. J. LODGE read a paper on "Intermittent Currents and the Theory of the Induction Balance." The telephone, as a scientific instrument, seems destined to play an important part as a detector of minute currents of rapidly changing intensity, and the general theory of intermittent currents is being brought into prominence by its use. The equations to which most attention has been hitherto directed have been those relating to the steady flow of a current after the initial inductive or inertia-like effects have subsided. The galvanometer is essentially an instrument for measuring steady currents or for giving the algebraically integrated expression for the total quantity of electricity which has passed in the case of transient currents. But the telephone plate has a very small period of swing compared to a needle, and, moreover, the plate is not limited to one mode of vibration like the needle. The induction balance was used experimentally by Dove and Felici, but was not appreciated as an instrument of research till Prof. Hughes applied to it the telephone and an intermittent current.

The general theory of the establishment of a current in circuits of known resistance was given by Thomson, and is to be found in Maxwell's "Electricity." Dr. Lodge used this theory in order to work out the theory of the Induction Balance, and one or two other cases of intermittent current, as completely as possible, without taking into account the electrostatic capacity of the wires, and leakage. The current in either primary of the balance is the same, and the current in either secondary is the same at every instant of time; in fact, the separating of the two balances of the circuits is immaterial to the theory. The current induced in the secondary circuit is a tertiary current induced from the third piece of conducting matter inserted between the primary and secondary. An expression being got for the strength of current in the telephone at any instant after a change in the resistance of the primary has occurred, the author deduces among other things the law according to which a small coin by its position and size, disturbs the balance. Dr. Lodge remarked that Prof. Hughes either by inventive intuition or great pains, had hit upon the best form of the apparatus for his purpose. The paper, which is very complete, is to be published in the *Philosophical Magazine* for February.

HERR FABER then exhibited his new speaking machine, which is designed to imitate mechanically the utterances of the human voice by means of artificial organs of articulation made on the human model, and actuated by an operator who depresses certain keys as in playing a musical instrument. The organs are a bellows made of wood and india-rubber, which answers to the lungs; a small windmill placed in front of the latter to give the "r" or trilling sounds; a larynx made of a single membrane of hippopotamus-hide and india-rubber to give the "drone" or basic tone of the voice; a mouth with two lips, a tongue, and a nose or proboscis made of india-rubber tubing placed below the mouth but curving up towards it. Fourteen distinct vocal sounds can be uttered by the instrument; but in combining these every word in any language can be played by the keys. Thus Herr Faber caused his machine to say such words as "Mariana," "Eliza," "Philadelphia," "Constantinople," and various sentences in French, English, and German, more or less distinctly. Laughing and whispering were also produced, and the voice of the instrument which was ordinarily loud and clear, and resembling that of a girl, was lowered in pitch and loudness to a more masculine tone.

SOCIETY OF TELEGRAPH ENGINEERS.

THE opening meeting of this society for the present year was held on Wednesday the 28th ult.

The chair, at the opening of the meeting, was taken by Lt.-Col. BATEMAN-CHAMPAIN, R.E.

The minutes of the previous meeting having been read and confirmed, Lt.-Col. CHAMPAIN introduced the new President, Mr. W. H. PREECE. A vote of thanks having been proposed to the retiring president by Professor ABEL, F.R.S., and seconded by Sir CHARLES BRIGHT, Mr. PREECE took the chair and read his inaugural address—a full report of which is given elsewhere in this Journal.

At the conclusion of the address a vote of thanks was proposed to Mr. PREECE by Mr. LATIMER-CLARK and seconded by Mr. C. E. SPAGNOLETTI. A ballot for proposed new members having then been taken, the meeting adjourned till February 11th.

City Notes.

Old Broad Street, Jan. 29th, 1880.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—An extraordinary general meeting of this company was held on Thursday, the 22nd ult., at the City Terminus Hotel, Cannon Street, Sir EDWIN WATKIN, M.P., presiding, for the purpose of varying the borrowing powers conferred by an extraordinary meeting in December last, and authorising (in addition to the borrowing powers conferred on the directors to the extent of £250,000) the creation and issue of debentures to the further amount of not exceeding £250,000. The Chairman said he explained at some length to the last meeting the reasons why the plan of redemption from their difficulties which he had proposed should be varied in deference to what was looked upon by many as a better one. He then told them that the question of the adoption of the better plan had been settled in principle, and that there was no reason to expect it would break down in detail. That detail was referred to Mr. Mendel, the deputy-chairman, Mr. Cooke, and the members of the Finance Committee, who had been devoting themselves to the settlement of the question, and now reported that they expected payments on account within a very few days. They might therefore consider the matter settled, subject to the passing of the necessary resolution as follows, which he proposed: "That the borrowing powers conferred by the extraordinary general meeting, held on December 22nd, 1879, be varied, and that in addition to the sum of £250,000, which the directors are empowered to borrow under the 17th article of association, the directors be authorised to create and issue debentures to the further amount of £250,000, for the purpose of providing for the redemption of the whole or any portion of the 'A,' 'B,' or 'C' debentures of the Company, and for the general purposes of the Company;" that really meant giving them power to borrow £500,000 instead of £250,000. This would enable them to meet the debentures coming due, pay off their debts, repair the cable, and leave a margin of £50,000. Mr. MENDEL seconded the resolution. In reply to a shareholder, the Chairman said that there were £303,000 of debentures of all kinds falling due in August next, their debts amounted to about £50,000 or £55,000, they wanted £40,000 to provide a new cable, and the "C" Debentures not yet drawn would take another £50,000. That made in round numbers £450,000, and the remaining £50,000 would remain as a margin to meet any future contingencies. The motion was then put to the meeting, and passed unanimously, and a vote of thanks to the chairman closed the proceedings.

EASTERN TELEGRAPH COMPANY (LIMITED).—The fifteenth half-yearly ordinary general meeting of the shareholders in this Company was held on the 22nd ult., at the City Terminus Hotel, Cannon Street, under the presidency of Mr. JOHN PENDER, M.P. The report of the directors for the six months ended 30th September last stated, *inter alia*, that the Company's revenue for that period amounted to £229,095 5s. 8d., from which was deducted £60,538 3s. 1d. for the ordinary expenses of the Company and £19,140 11s. 8d. for special expenditure during the half-year, which, with £3,112 16s. 11d. for income-tax, left a balance of £146,303 14s. From this amount, £38,599 5s. 5d., the interest on debentures and the dividend on the Six per Cent. Preference Shares to the 30th September, together with two interim dividends on the ordinary shares for the quarters ending 30th June and 30th September, 1879, amounting together to £131,024 5s. 5d., had been paid, leaving a balance of £15,279 8s. 7d. to be carried forward. The several sections of the Company's cables continue in good working order. The Chairman, before moving the adoption of the report, amongst other remarks, said: "I think, if you will indulge me for a time, that this is an occasion on which we may fairly review a little the position of this Eastern Telegraph Company (hear, hear). The South African cable has just been completed, and it is an event on which I think we may all congratulate ourselves. It is only six months ago, at our general meeting last July, that I brought the question before you, and got your approval to certain resolutions which I then placed before you in order to enable us to take part in that important work. To-day we have to congratulate ourselves on its completion, and, as I have said, I think I may now review a little the past history of this Company, so that the shareholders may fully understand the valuable property which they possess. A glance at the map of our system will show that we have triplicate cables to Malta and Egypt, and duplicate cables to Spain, Portugal, Gibraltar, Aden, and India. From Aden the cable is continued to South Africa, and from India the lines of the Eastern Extension Company bring us into connection with the Straits Settlements, Cochin China, Japan, Java, Australia, and New Zealand. We have also a network of cables in the Mediterranean running from Greece to Tenedos, on to Salonica, and through the Bosphorous to Constantinople, with a cable in the Black Sea to Odessa, and another from Alexandria to Cyprus—indeed, nearly every place of importance in the Levant is connected with one of this Company's cables. The whole mileage and capital is as follows:—The Eastern Company has now a total of 16,331 miles, and a total capital of £5,279,000; the Eastern Extension Company has 9,928 miles, and a capital of £2,957,000; and the South African Company has 3,925 miles, and a capital of £950,000. That makes a gross total of 30,184 miles of submarine cable, and £9,186,500 of capital. The important link now completed, which connects the South African Colonies with our system at Aden—a mileage of about 3,925 miles, and which is to be, for financial reasons, worked under the title of the Eastern and South African Telegraph Company—is the most important connection for length, and, so far as we can now judge, also likely to be for profit. It will be in the recollection of many of the shareholders that the Eastern Telegraph Company as now constituted was formed in 1872 by the amalgamation of the following companies:—The Anglo-Mediterranean, Falmouth, British Indian, and the Marseilles. I may mention that I am giving you this information to-day because there is an impression abroad that our system has been very seriously 'watered,' but I think I shall be able to show you by figures that we stand in a thoroughly respectable position as regards that question. Well, then, to place the shareholders in these separate undertakings on an equality—for at that time there was a great clamour for amalgamation—a certain number of bonus shares was allotted. The amount of these bonus shares was £957,000, or about 18 per cent. of our gross capital of £5,279,000. Thus the original shareholders, as pioneers of the enterprise, obtained a certain advantage over those buying later, and they are to-day earning about 7½ per cent. We are paying a dividend of 5 per cent., but those who joined the Company at the beginning are actually receiving 7½ per cent. on their money. But inasmuch as our shares stood for a long period at a discount of 30 to 40 per cent., which price gives a return of about 7½ per cent., a very large proportion of what I would call our later shareholders are in as good, if not rather a better position, than the original pioneers of the Company. The present price of our shares is about

10 per cent. discount, showing that the public begin to realise the improving nature of our property. For some years our traffic has been practically stationary. I have had to tell you at meeting after meeting that this arose in a great degree from the depression of trade which has visited not only our own country, but which has prevailed over every part of the world. I have also said that there was no better barometer of trade than the telegraph system, and I am glad to state to you to-day, as you all know, that trade is reviving not only here, but in every part of the globe, and that we are now beginning to rise considerably in the scale of improved and increased traffics (hear, hear). I may say this—that whereas twelve months ago we were probably earning about 6½ per cent., I believe that this last week we have earned nearly 11½ per cent. Another point I wish to bring before you is this. We have completed this South African system—the Eastern Telegraph Company, and the Telegraph Construction and Maintenance Company have literally completed the whole of that important work. We, the Eastern Company, hold £200,000 of shares in the South African Company; we shall hold them to all time, and we shall hold them because we believe from what we see that this will be a very important and valuable feeder to the Eastern Company's resources. We have also the advantage from this connection in having a considerable increase in traffic over our line from the African system. We had also to take as our portion £200,000 of debentures. We have offered those debentures before the cable was completed to our shareholders. They have not all been taken up. A considerable portion—something like £300,000—has been taken up out of £600,000, and the balance is held by the Telegraph Construction Company and ourselves. Such is the improved prospect at the present moment, for the cable gives such satisfactory results that we have got the Telegraph Construction Company to give us the call of those debentures for a very short period, so that we may offer them to our Eastern Company shareholders. I therefore intend to send a circular to our shareholders offering them *pro rata* these debentures."

DIRECT UNITED STATES CABLE COMPANY.—The Board of this Company have resolved upon the payment of an interim dividend of five shillings per share, being at the rate of five per cent. per annum for the quarter ending 31st December, 1879, such dividend to be payable on and after the 16th February, 1880.

THE EASTERN EXTENSION TELEGRAPH COMPANY (LIMITED) notify that the interest due on their Six per Cent. Debentures will be paid on and after the 1st of February at the Consolidated Bank.

LA COMPAGNIE FRANÇAISE DU TÉLÉGRAPHE DE PARIS À NEW YORK.—This Company's cable is now open between France and America. Messages intended for that route must bear the indication "*via* P. Q." This instruction will be transmitted free.

OWING to the opening of the cable communication just mentioned, the Anglo-American Company from February 1st reduce their tariff on continental messages (only) to and from America to 6d. per word; the other tariffs remain for the present as before.

The following are the final quotations of telegraphs for January 28th:—Anglo-American, Limited, 60-61; Ditto, Preferred, 85½-86½; Ditto, Deferred, 35-36; Brazilian Submarine, Limited, 7¾-8; Cuba, Limited, 8¾-9¼; Cuba, Limited, 10 per cent. Preference, 16½-17; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11-11½; Direct United States Cable, Limited, 1877, 10⅞-11⅛; Eastern, Limited, 8¾-9; Eastern 6 per cent. Preference, 11¾-12¾; Eastern, 6 per cent. Debentures, repayable Oct., 1883, 103-106; Eastern 5 per cent. Debentures repayable Aug., 1878, 102-105; Eastern, 5 per cent., repayable Aug., 1899, 101-103; Eastern Extension, Australasian and China, Limited, 8¾-9; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 107-110; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 100-102; Ditto, registered, repayable 1900, 101-103; German Union Telegraph and Trust, 8½-9; Globe Telegraph and Trust, Limited, 5¼-5⅝; Globe, 6 per cent. Preference, 11¼-11¾; Great Northern, 9-9¼; Indo-European, Limited, 23-24; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 10½-11; Reuter's Limited, 10-11; Submarine, 230-240; Submarine Scrip, 2½-2⅞; West Coast of America, Limited, 1¼-1¾; West India and Panama, Limited, 1⅜-1⅝; Ditto, 6 per cent. First Preference, 7½-8; Ditto, ditto, Second Preference, 6¾-7¼; Western and Brazilian, Limited, 6⅛-6⅝; Ditto, 6 per cent. Debentures "A," 100-103, Ditto, ditto, ditto, "B," 99-103; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 105-107; Telegraph Construction and Maintenance, Limited, 35-36; Ditto, 6 per cent. Bonds, 103-105; Ditto, Second Bonus Trust Certificates, 2⅞-3⅛; India Rubber Co., 13¾-14¼; Ditto, 6 per cent. Debenture, 106-108.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£ *a*	£	£	£	£	£	£	£	£	£	£ *a*	£
Dec., 1879 ...	59,010	12,524	3,000	1,551	19,670	45,704	26,025	16,936	... ...	*	*	10,747	4,834
Dec., 1878	47,040	14,231	3,095	940	13,970	38,467	22,929	14,803	... ...	8,498	... ...	... ...	5,442
Increase	11,970	... ...	... ...	611	5,700	7,237	3,096	2,133	... ...	... ...	... ...	... ...	... ...
Decrease	... ...	1,707	95	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	608

a Four weeks. * Not yet published.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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POSTAL TELEGRAPHS.

During the last few weeks much has been said and more still written on the subject of the British Postal Telegraph Department and its duties to the public and inventors. The recently instituted law-suits against the telephone companies had already drawn considerable attention to these questions, when some remarks made in the presidential address to the Society of Telegraph Engineers acted on the public press like at Woolwich a few days since the fuse did to the already overloaded gun.

The telephone exchange system and telephony generally are gaining ground in our towns at a fairly rapid pace, and, as they progress, will inevitably extend with increasing rapidity for some years to come. As the telephone is capable of so much, and as the Postal Telegraph Department is now to some extent adopting it, it seems to us a pity that more encouragement was not given to its development at first, as there would then have been less sympathy accorded, and justly so accorded, to the telephone companies.

It is true that the Department cannot be always changing its instruments, especially if little or no advantage is to be gained thereby; but with the telephone the case is entirely different, foreshadowing as it did, and does, a new era in telegraphic communication, and not being in itself merely a modification or re-arrangement of some pre-existing species of apparatus.

With the transference of the businesses of the various telegraph companies to the Post Office grave responsibilities were created for those in authority at St. Martin's-le-Grand. Amongst them may be mentioned the cherishing of inventions which previous competition had effected, and also the giving to the public the utmost practicable facilities for telegraphic intercommunication.

Perhaps it is an inevitable consequence of so sweeping a change that some must suffer, and undoubtedly the manufacturers of instruments have had a bad time, and several of the smaller makers have been utterly swept away. With inventors, however, if the advance of the science is not to languish or cease in this country, it is necessary that they should have the utmost latitude allowed them to experiment, and moreover they should have practical and substantial support as soon as the utility of their experiments has been clearly demonstrated.

We do not think inventors will complain much of the treatment they receive at the hands of those in power at the G.P.O., nor do we think that public business is to be much improved except in the important matter of rates generally, and in improved means of communication in suburban and outlying districts; but both inventors and the telegraphic service will be benefited if the rigour of the economy forced on the Telegraph Department by the public itself is got rid of. It is by no means necessary that the telegraphs should pay a dividend, and we are glad to perceive public opinion has at last, as it frequently does, swung completely round, and is now calling for those advantages which will necessitate increased expenditure, and which expenditure it has hitherto strongly deprecated.

It is to be hoped that in the near future the Post Office administration, now that public opinion has manifested itself so unmistakably, will see its way to a more liberal support of inventors, and also to an increase in facilities for the telegraphing public, in the direction we have indicated, even perhaps to a considerable reduction of rates; for what matters it the spending of a few hundred thousands on more instruments and lines for increased traffic if the public are the gainers to a still greater extent by the better communications afforded, and although the Department might then show a deficit instead of, as now, a slight surplus?

But it is certain that neither of these changes can be made unless the Government will consent to the increase of expenditure, and it is rather in this direction that the public must agitate than cast obloquy upon those who in no way deserve it.

Surely we are not so poor or puny a nation that we cannot allow pecuniary reward to inventors and pecuniary support to a department which can and must be maintained—the first, the most complete, and the most enterprising of its kind in the whole world.

THE BERLIN ELECTRICAL RAILWAY.

In a recent number of *La Nature*, M. E. Hospitalier has given a description of the apparatus employed on this railway. Referring to the heading of the article, viz., "The Electric Traction of Aerial and Subterranean Railways in Large Towns," he says :—"The title of this article is of a nature likely to produce incredulity in our readers, even amongst those who are familiar with the recent marvels of electricity. In truth, a similar idea conceived twenty years ago, would have assuredly only brought down a

storm of sneers on the heads of those who had dared to suggest it; but the discoveries which have taken place since that time have rendered the question worthy of serious consideration, inasmuch as it has been shown lately in the capital of the German empire to be quite practicable.

"The electric railway of Berlin, which has worked during the whole of the Exhibition of 1879, is merely an application of *the transmission of motive power to a distance by electricity;* we will now explain the principle of the apparatus in a few words.

"If we connect the magneto-electric, or dynamo-electric machines, A and B, by metallic conductors, and we cause one machine to be moved by power, the electricity generated will cause the other machine to rotate with a nearly corresponding amount of power.

"It is clear that the machine, B, will only rotate with but a portion of the power generated by A, and the form of electricity, and able to exercise an amount of work varying from three to six horse-power. By attaching small carriages to this locomotive, we have the electric railway which Dr. Werner Siemens, the eminent electrician, has established at Berlin.

"Figs. 1 and 2 show end and side sectional elevation of the locomotive drawn to $\frac{1}{10}$th scale.

"The dynamo machines employed are those of the Siemens pattern, working with continuous currents; both the generating and working machine are of the same dimensions.

"The machine is shown in side sectional elevation by fig. 2; on this fig. is seen a longitudinal section of the bobbin which, set in motion by the electric current, transmits its movements to the driving-wheels by a series of cog-wheels, *l, t, v, x, y.* This train of wheels is necessary in order to make the velocity of the wheels less than that of the bobbin,

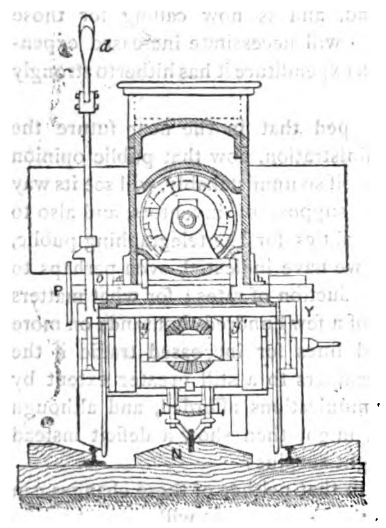


FIG. 1.

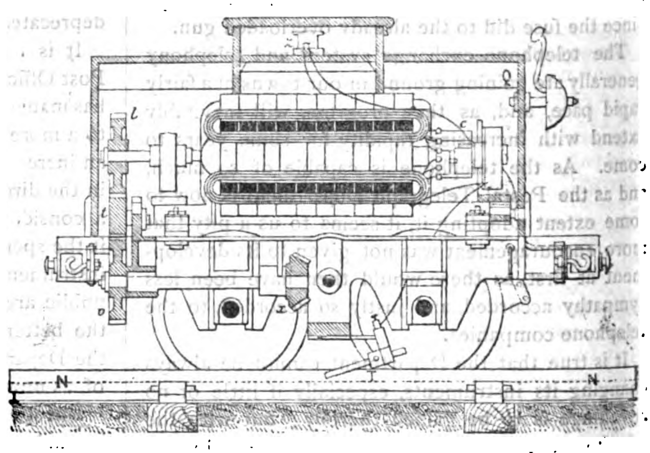


FIG. 2.

that the relation between the work given out and the work produced will vary according to the nature of the machines, their relative velocities, their power, and the length of the conductors which join them; in certain cases the power utilised is as much as 60 per cent., and even with conductors of great length it seldom falls below 30 per cent.

"If we take a dynamo-electric machine of ten horse-power force, turned by a steam engine, and we connect it by conductors to a second dynamo machine placed on a car, the wheels of which can receive a movement for this second machine, we shall have thus constituted an *electrical carriage* which will work so long as continuity is kept up with it by means of the conductors.

"In placing our carriage on rails and utilising, on the one hand, these rails so as to form one of the conductors connected with the machine by the medium of the wheels, and on the other hand, a central rail well insulated so as to form the second conductor, and conveying the current to the machine by *brushes* always in contact with the rail we shall then have an *electric locomotive* receiving the motive force under and to conveniently arrange the whole of the apparatus.

"The generating machine has one of its poles connected to the rail of the railway, and its other pole connected to the central rail, N (figs. 1 and 2), formed of an iron bar on a well insulated support. A pair of brushes formed of fine copper wires, like the Gramme machine collectors, rub constantly against the central rail, N, and establish continuous electric communication between one of the poles of the machine placed on the locomotive and the rail. The current arrives then by the rail and the brushes, traverses the wires of the dynamo machine placed on the locomotive, and returns to the source of electricity by the wheels and the ordinary rails.

"The carriages are metallically connected to the locomotive, so that their wheels establish a more perfect communication than could be obtained from the wheels of the locomotive alone. The cutting off and putting on of the current is effected by an ordinary switch, which can be worked by the left hand of the engine driver whilst his right hand controls the brake. Experiments made with a train of

this description carrying 18 passengers, showed that a velocity of 1·88 metres per second could be attained, this being represented by an effective horse-power equal to two, without counting the work expended in moving the locomotive itself. In the Exhibition building the speed marked was 3·50 metres per second (12·6 kilometres per hour), the work developed being equal to 3½ horse-power."

Recently at the general meeting of the new Electro-Technic Society—a body rapidly assuming importance among the philosophical associations of the German capital—the Postmaster-general, Stephan, presiding, Dr. Werner Siemens made a most interesting statement upon the impending construction of an electric railway. Fifteen feet above the pavement he proposes to construct a network of electric lines, intended to convey passengers from the various stations of the new metropolitan line to all parts of the capital. To work these lines with ordinary locomotives would be impracticable, unless, indeed, the pillars on which the metals would have to be placed were very solid and of a nature not to interfere with the traffic of crowded streets. The electric railway required no such heavy structures, the moving power being the new dynamo machine, invented by the speaker, and perfected by Herr von Hefner, one of the leading engineers of his firm. For its working capacity the machine was indebted to a very simple contrivance. By revolving his machinery in the direction opposite to the current he had not only obviated reduction of force, but actually augmented its strength. This theory, which was communicated by him 13 years ago to the Berlin Academy, had since been applied by Dr. Siemens and his associate, Herr von Hefner, to the construction of an electro-dynamo engine, whose perfect working capacity was tested in the electric railway of the Berlin Industrial Exhibition of 1879. The machine was so very powerful that the chief difficulty in perfecting it had been to prevent its destruction by its own inherent force. The action of the machine, too, was cheaper than that of the locomotive: a train consisting of machine and passengers' carriage could be profitably run on his viaduct railway if there was an average of five travellers. Considering that the electric viaduct admitted of being placed on slight and elegant columns, it was obvious that this new species of railway supplied a ready means of freeing the streets of crowded capitals from the excessive traffic now obstructing them. He was not prepared to say that the new invention would supersede locomotives for long distances, a dynamo machine in connection with the engine requiring to be put up every twenty miles; but as its applicability for short distances had been absolutely proved, omnibus and tram were clearly destined to become obsolete very shortly, and metropolitan communication would be conducted upon a new and highly improved plan. In conclusion, the speaker hoped that Berlin would be the first city to adopt this promising contrivance.

Dr. Siemens then discussed the feasibility of employing his engine for increasing the traction power of locomotives in overcoming ascents too steep to admit of the requisite friction of the wheels. He also showed that the Berlin postal *trabes*, in which letters are conveyed by compressed air, might be more advantageously worked with his dynamo machine.

EFFECTS OF A THUNDERSTORM ON A TELEGRAPH LINE IN NEW ZEALAND.

By W. H. FLOYD, M.S.T.E., Superintendent of New Zealand Railway Telegraphs.

ON the afternoon of the 11th of November, this year (1879), a violent thunderstorm was experienced on the Malvern branch of the New Zealand system of railways in the Middle Island, and considerable damage resulted to the railway telegraph line between Darfield Junction and Hawkins Stations.

Nine telegraph poles were more or less damaged, and six of them were so badly shattered and splintered as to be no longer serviceable; the remaining three, although considerably shaken, were good enough to be refitted and continued in use as telegraph poles. The damage to poles extended over a straight line of three-quarters of a mile in length, but all the poles in that length were not injured.

Commencing three-quarters of a mile from Darfield Junction, the first pole was badly shattered, and only about a third of it left standing, the other two-thirds being split up into small fragments and scattered about. The next pole towards Hawkins Station was perfectly sound. The third was as badly injured as the first, but the fourth and fifth were uninjured. The sixth, seventh, and eighth were badly shattered and splintered from their tops to the ground-line.

Between the seventh and eighth poles, at about the centre of the span, and also at about midway between the first and the last pole injured, the telegraph wire of No. 8 gauge was fused and parted, and over the whole of the 21 feet distance between the line of wire and the railway metals the ground showed signs of disturbance. Three railway sleepers were shattered, and between one of them and the line of wire there were two strongly-marked paths, resulting from the storm. The paths were joined just at the sleeper, but divided almost immediately, and remained distinctly separate until they disappeared altogether—six feet apart—directly under the line of telegraph wire. It appeared as though there had been an independent path made between each separated end of the fused wire and the railway metals.

The paths were tunnelled part of the way to a depth of from twelve to fifteen inches underground, and to a diameter of about five inches, and part of the way they were cut to a depth of from four to five inches from the surface. The earth thrown up at the sides of the surface cuttings exhibited, in patches, a greyish colour that suggested the idea of its having been under the influence of fire.

The ninth pole had only a piece of its top splintered off, and could be refitted. Between this pole and the railway metals there was a single path, partly tunnelled and partly cut from the surface, as previously described. In both cases the disturbance of the ground was greatest near the railway metals, and gradually decreased until it ceased altogether under the line of telegraph wire. The tenth pole was only slightly shaken near the ground-line. The eleventh had a slice two inches thick cleanly taken from under its arm to the ground-line, and the slice was splintered into matchwood. The next three poles were uninjured, and the signs of damage ceased altogether at the fifteenth pole, which was

badly shattered. None of the poles were provided with lightning conductors.

At the Darfield Junction telegraph office the station-master and telegraphist were seated writing, when they saw a bright light apparently leap from one of the instruments to the floor, and heard a noise like the report of a fowling-piece.

The instruments remained in working order, but it was afterwards found that the local contacts of a Siemens polarised relay showed signs of the lightning. Part of the surface of the platinum contact piece on the armature was fused, giving the appearance of a circular space about one-eighth of an inch in diameter having been tooled out of it in a lathe, except that the bright surface inside the circle had minute glistening feathery particles of platinum left on it; and the platinum point, with which the piece on the armature makes contact to complete the local circuit, had a roughened and discoloured appearance, due to its surface having been fused.

The glass top on the relay was also spotted just above the local contacts with innumerable dots that had a bright metallic appearance under a magnifying glass. These spots were much brighter and more clearly defined on the inner than on the outer surface of the glass top of the relay.

The Darfield Junction office was fitted with Siemens grooved-plate lightning guards, placed between the leading-in wires and the instruments.

UTILISATION OF THE TIDES.

As we pointed out in a recent number of the *Journal* (Oct. 1st, 1879), the solution of the problem of the transmission of motive power to a distance by means of electricity is likely to prove of the highest importance in enabling that inexhaustible source of power—the tide—to be utilised. The scientific world, up to the present, has shown but little signs of a determination to fairly grapple with the general problem, and it is only by a fitful attempt now and then that the matter is drawn attention to. It is possible that the difficulties in the way have up to the present seemed so insurmountable that any attempts to deal with the subject have been considered to be mere waste of time; but, still, now and then we hear of the question being discussed. Recently, an excellent paper was read before the Liverpool Engineering Society, by Mr. Arthur Oates, on "The Utilisation of the Tides," in which some simple calculations were given which placed the matter in a very clear light and which are highly interesting. The following are Mr. Oates' calculations:—

Approximate Table

Showing the power and value of the vertical motion of tides per square mile, if a little over 25 per cent. of the latent power is utilised.

Range in Feet.	Horse-power of a square mile.	No. of sq. yds. of sea surface which produce 1 H. P.	Value of a square mile per year.	Allowable capital to be sunk in utilising works per square mile.
			£	£
5	469	6,605	1,172	5,860
10	1,877	1,650	4,692	23,460
15	4,223	733	10,557	52,785
20	7,509	412	18,772	93,860
25	11,733	264	29,332	140,660
30	16,895	183	42,237	211,185

Explanation.—The first column of this table gives the range, which may be taken either for that of mean or of neap tides; six different ones are selected for these calculations, every five feet, from five to thirty, which will include all the most common tides on our coasts. The second column gives the horse-power per square mile; this is obtained by multiplying 27,878,400—the number of square feet that a square mile contains—by the range, which will give the cubic feet of water moved by each tide per square mile; this divided by 35—the number of cubic feet of sea-water which weighs a ton—will give its weight in tons. This falls on an average half the range *nearly* four times per day; but as a little over 25 per cent. of the actual power being utilised is only reckoned, the weight of water moved per square mile is multiplied by half the range once only; this gives the feet tons of power per day of 24 hours, and divided by 21,214·3—the number of feet tons a horse-power equals per day of that length—will give the horse-power of a square mile. 3,097,600, the number of square yards a square mile contains, divided by the horse-power of a square mile, will give the number of square yards it will take to produce one horse-power, which is given in the third column. As about half a hundredweight of coal is consumed per day of 24 hours for each indicated horse-power of a steam engine, twopence—the value of that quantity of coal—is taken as the value of a horse-power per day of 24 hours. If the tidal power is only required during a portion of the day the remainder could be stored, therefore all the power utilised during the 24 hours may be reckoned as saleable, but only 300 days per year are so reckoned. The value of a square mile per year is obtained by multiplying the horse-power first by 2, then by 300, which gives it in pence, and this divided by 240 will give the value in pounds, as shown in the fourth column.

The fifth gives the amount of capital that may be sunk in utilising one square mile; this is obtained by multiplying its value per year by 5, which gives the amount of capital that would produce, at 20 per cent., interest of the same value, this will allow 15 per cent. for expenses, and a dividend of 5, or, if the expenses only took 10 per cent., a dividend of the same amount could be paid.

This table, as its name implies, gives only approximations to the true amounts; but it will probably be found to err in under, rather than over, estimating the value of tides.

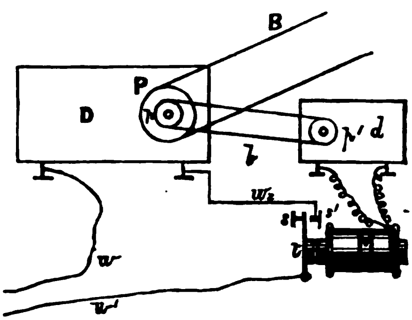
The power and value of any tidal inlet can be roughly calculated, by multiplying or dividing—according to its size—the amounts given in the table opposite the required range by the area of the inlet. And by estimating the probable cost of the utilising works, and comparing it with the "allowable capital," an idea may be formed of the probable financial success of the undertaking. In ascertaining the area of a tidal inlet, allowance should be made for the beach and banks uncovered at low water, and also for the quantity of fresh water flowing into it if great in proportion to the size of the inlet, otherwise the power and value calculated from the table will be too great. If the beach and banks are of a uniform gradient between high and low water marks, the area of the water at half tide may be taken as the true superficies of the inlet. The third column will be found of use in

calculating the area required to produce a given amount of power at a given range.

Mr. Oates has pointed out that one of the difficulties in utilising the tidal force consists in the adoption of an efficient system of storage of the power; this difficulty, he mentions, may be overcome by storing the force, in the form of water decomposed into its constituent elements by electrical decomposition, the electricity being generated, of course, by a dynamo machine worked by the tidal power.

ZANNI'S PATENT MAGNETIC CUT OFF FOR DYNAMO-ELECTRIC MACHINES.

THE object of this invention is to prevent a reversal of the polarity of the electricity employed in the process of the electro-deposition of metals and generated by means of dynamo-electric machines. It is a well known fact that in the process of depositing metals by means of an electric current generated by a dynamo machine, that whenever the machine ceases to work a current generated by the action of the electrodes in the depositing bath returns through the dynamo machine and reverses its polarity, consequently when the machine is again started the metal deposited on the article being plated becomes, by a reversal of the required process, denuded of its metallic coating instead of having the thickness of the same increased. Several devices have been suggested and tried for overcoming this defect, but most of them, for some cause or other, have been unsatisfactory and uncertain in their action. The invention of Mr. Zanni



for effecting the object in view has been tested and proved to be thoroughly reliable in its action, and is therefore a very useful addition to the electroplater's plant.

The principle of the invention is shown by the fig.

D is the dynamo machine driven by the band B, which is connected with the source of power. On the same axle to which the driving pulley, P, of the machine is fixed, is also attached another pulley, *p*, which drives by means of a band, *b*, and pulley, *p'*, a small magneto machine, *d*; the circuit of this machine is closed through the electro-magnet, M. The armature, *t*, of the electro-magnet normally rests against the insulated stop, *s*; but when the magnet is excited it is attracted against the stop, *s'*, thus completing the circuit of the wires, *w*, *w'*, which lead to the depositing bath through the connection, w_2.

The action of the apparatus is almost self-evident: when the machine is at rest the circuit of *w*, *w'* is open, but when the dynamo machine, D, is rotated and with it the magneto machine, *d*, the current from the latter at once excites the electro-magnet, M, and attracts the tongue, *t*, against the stop, *s'*, thus closing the circuit of *w*, *w'*; the moment the machine stops, the tongue, *t*, falls back against the stop, *s*, thus opening the circuit and preventing the return of the current from the depositing bath through the machine, D.

In the number of the *Journal* for December 15th, 1879, in a notice of Mr. Urquhart's book on electroplating, we expressed our surprise that a simple form of rheostat had not been adopted in electroplating operations for the purpose of regulating the strength of the current; on reference to a patent of Mr. Zanni's we find that this has been suggested and patented by him together with the use of a galvanometer in the circuit, by which the current strength could be seen.

Although fully recognising the efficiency of Mr. Zanni's magnetic "cut off," we should have thought that the same end could be effected in a simpler manner by working the electro-magnet, M, by a "derived" circuit from the machine, D, the resistance of the electro-magnet being sufficiently high to avoid drawing off more of the current than is actually required to excite the electro-magnet. The amount of current required to excite M, it is evident, would be but an infinitesimally small portion of the total current, and would therefore in no way diminish the efficiency of the machine.

MACHINERY AND APPARATUS EMPLOYED IN THE LAYING OF THE NEW MARSEILLES-ALGIERS CABLE.

II.

Electrical Testing Apparatus.

THE testing arrangements employed during the laying of a cable are of great importance, as upon their proper management depend the early discovery and accurate localisation of any fault which may occur during the submerging operation. It is very essential that the means adopted should be such as will enable both the ship and shore to notice when a fault takes place, so as to enable them to make accurate comparable measurements to localise the defect. The method adopted by the Silvertown electricians, and employed on board the *Dacia*, is one of the best systems, and has been used with great success on most of their cable expeditions; the principle of the system is shown by figs. 1 and 2, fig. 1 being the arrangement on board ship, and fig. 2 the arrangement on shore.

The end of the cable on board the ship is well insulated and connected through a Thomson galvanometer with a battery of about 200 cells. On shore a condenser is provided, one terminal of which is connected to a brass lever which plays between two insulated contacts; one of these con-

tacts is connected to the second terminal of the condenser, which latter terminal is also connected, through a Thomson galvanometer, to earth; the other contact is connected to the conductor of the cable. The battery connected to the cable on board the ship charges the former to a certain potential, and the value of this potential will be the same throughout the whole length provided no fault exists. If the lever on shore be moved against the contact connected to the cable a portion of the charge in the latter will rush into the condenser and will charge up the set of plates to which it is connected to the same potential as the cable; the second set

SHIP.

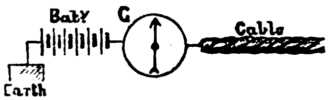


FIG. 1.

SHORE.

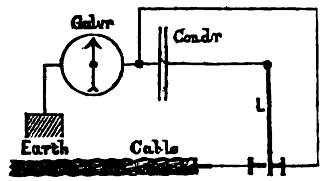


FIG. 2.

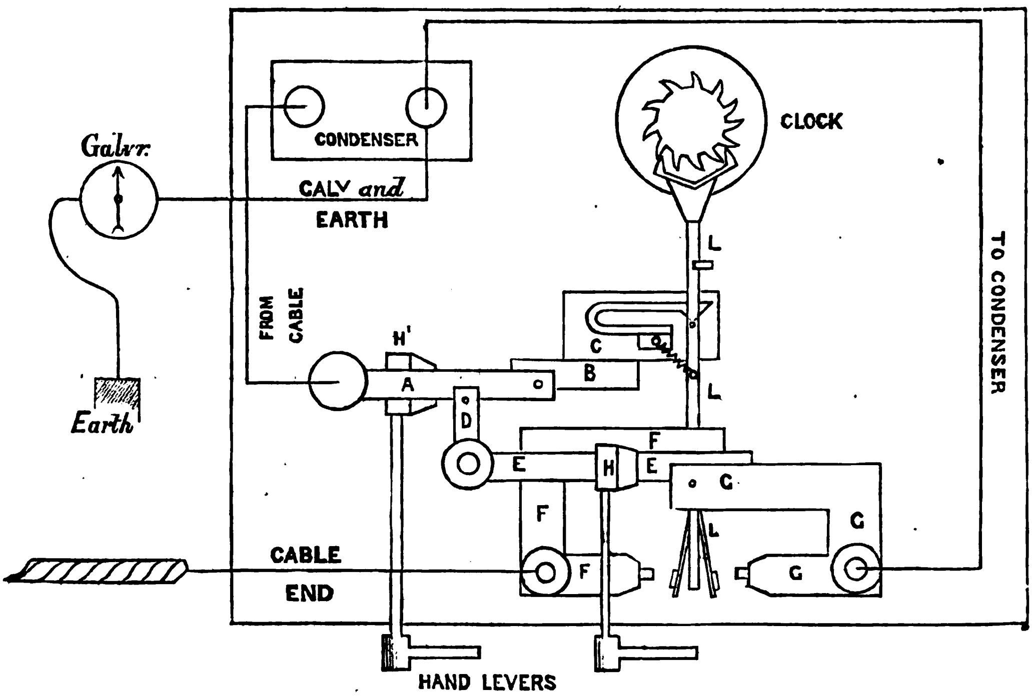


FIG. 3.

of plates will become charged to the opposite potential by a charge rushing in from earth through the galvanometer; this in-rush will produce a *throw*, or momentary deflection of the needle, the amount of which will represent the potential of the charge in the condenser, that is, the potential at the end of the cable. If now the lever be moved from the cable contact to the contact connected to the condenser, the latter will be short-circuited and discharged. The rush of the charge into the condenser when the latter is connected to the cable contact, produces a simultaneous rush into the cable from the battery on the ship, and as this takes place through the galvanometer on board the ship a sudden throw is produced on the needle. Now if a fault occurs during the laying, the *steady* deflection on the ship's galvanometer, which is due to the flow of current through the dielectric of the cable, and which is distinct from the *throw* which takes place when the condenser becomes connected to the cable at the shore end, becomes greatly increased and renders the presence of the fault evident immediately. On the shore the effect of the fault is to reduce the potential at that end of the cable, and consequently the charge which the condenser takes becomes correspondingly reduced; when then the condenser becomes charged through the galvanometer a reduced throw is produced which thus shows the shore the existence of the fault.

The lever on shore which charges and discharges

the condenser is moved by clockwork which causes it to act every five minutes, so that every hour twelve throws are observed on each galvanometer. At the end of every hour the ship reverses the battery so that the direction of the throws is changed.

In order to enable the ship to communicate with the shore, instructions are given that if at the end of the hour the throws do not become reversed, or if they become reversed before the expiration of the hour, it is a sign that the ship wishes to communicate with the shore; in this case, then, the shore disconnects the cable from the clock lever and connects it with the speaking apparatus, and as the ship does the same, the necessary communications can be carried on. If, on the other hand, the shore wishes to call the attention of the ship he can do so by moving a lever corresponding to the clock lever two or three times quickly by hand; the ship then observing that the throws on her galvanometer take place quickly, instead of at intervals of five minutes, immediately joins up her speaking apparatus, and thus communicates with the shore.

As it is advisable that the operation of disconnecting the cable from the clock lever contact and connecting it to the hand-worked lever shall be done without difficulty, the arrangement of the apparatus is such that this can be performed with great facility.

The whole of the arrangement is shown by fig. 3. A is a brass tongue, whose normal position, while the clock-work is in operation, is on contact plate B; this plate is connected with the plate C, which plate is also connected by a small spiral spring with the lever L, L. D is a contact plate which is free while the clock is working. E, E is a brass tongue which in its normal position is in contact with the piece G. To the contact plate F the cable end is attached, and to G the condenser is connected. The lever L, worked by a ratchet-toothed wheel connected to a clock, makes contact every fifth minute on the contact at F, returning, after making this contact, to G. H' is a cam on the end of a hand lever, which is used for moving the tongue A from its normal position on B to the contact at D, thus switching out the connection with the lever L when signals are to be given by hand. H is a cam on the end of a second hand lever; this is used for giving signals by hand (when the clockwork and the lever are cut out), by pressing the tongue E down on the plate F, to which the cable is attached. When the clock is at work the current passes from F to lever L, on to plate C, and thence *viâ* B and A to condenser. When hand signals are given, the current passes from F to E, D and A, and thence to condenser. When E returns to normal position at G the condenser is discharged.

In order to render the motion of the lever, to or from a contact, quick and decided, the bent spring on the plate C is provided; this has a conical piece at its end which presses against a pin on the lever; as the lever moves under the action of the clock wheel, the pin acts against the inclined side of the conical piece, and moves it until the apex is reached and passed, when the action of the spring immediately drives the lever over sharply against its contact. A similar action takes place when the lever moves in the reverse direction. The amount of play given to the springs at the end of the lever L is such that they do not break contact from F or G, as the case may be, until the point is passed at which the lever is thrown sharply over.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

III.

THE BRIGHT'S BELL INSTRUMENT.

THIS form of instrument was patented by Mr. C. Bright (now Sir Charles Bright) in 1853, and was almost exclusively used by the "Magnetic" Company, it having superseded the Magnetic Needle instrument of Henley and Foster.

The instrument is an "acoustic" one, that is to say, it gives signals by sound, like the single needle instrument fitted with the Neale acoustic dial. To this latter form of apparatus indeed it is closely allied, inasmuch as the two forms are worked and read from in identically the same manner.

The apparatus consists of three parts, viz., "the Tappers," "the Relay," and "the Bells."

"THE TAPPERS."

Either of the two forms of tappers which are used in the "Single needle" instrument and which are fully described in Articles I. and II., can be used with the Bell instrument; the way, however, in which they are connected up to the apparatus differs slightly from the method employed with the single needles.

In the latter form of instrument the portion of the apparatus from which the signals are read, that is to say, the "Dial," is equally affected by the outgoing and the incoming signals; in the Bell instrument only the incoming signals or currents work the acoustic signalling apparatus, the outgoing signals pass direct to line without working the latter.

The way in which the connections are made in order to effect this result is shown by fig. 14, which represents the ordinary form of tapper keys joined up in circuit with the rest of the apparatus. Referring to this figure, it will be seen that in the key the terminals X and Y, which for the single needle instrument are kept connected together by means of a brass strap (seen in fig. 1, Art. I.), are in the Bell instrument connected to the D and U, that is, the "Down" and "Up" line, terminals of the receiving portion of the apparatus; the strap being of course disconnected from X and Y. The other connections are precisely similar to those shown in fig. 2 (Art. I.), which represented the connections for the single needle instrument; that is to say, the battery is connected to terminals Z and C, the "Up" line is connected to A, and the "Down" line is connected to T through a single needle dial, S N, which dial is now attached to all of the Bell instruments, in order to enable the signals to be read visually if necessary.

Action of the tapper.

As regards the transmission of signals the action of the tapper and the course of the current is identical with that in the case of the single needle instrument, viz., when the left-hand pedal is depressed, then the Zinc pole of the battery becomes connected to the block, *h*, and thence by the end of the spring, *v*, to the cock, *f*, thence to terminal A and on to the "Up" line of the circuit. The Copper pole of the battery being in connection with the block supporting the spring, *s*, s^1, becomes con-

nected with the projecting piece, *t*, and thence through the left-hand hinge block with the terminal T, and from there through the dial, S N, to the "Down" line.

If the right-hand pedal be depressed, the Zinc pole of the battery becomes connected with the cock, *g*, through the end of the spring, v^1, thence ment from another station, then the course of the current, supposing it to enter from the "Down" line, will be as follows:—From the "Down" line through the dial, S N, to the terminal T, thence through the left-hand hinge block and the tongue, *t*, to contact block, *k*, from there it passes by X to terminal D of the receiving portion of the apparatus,

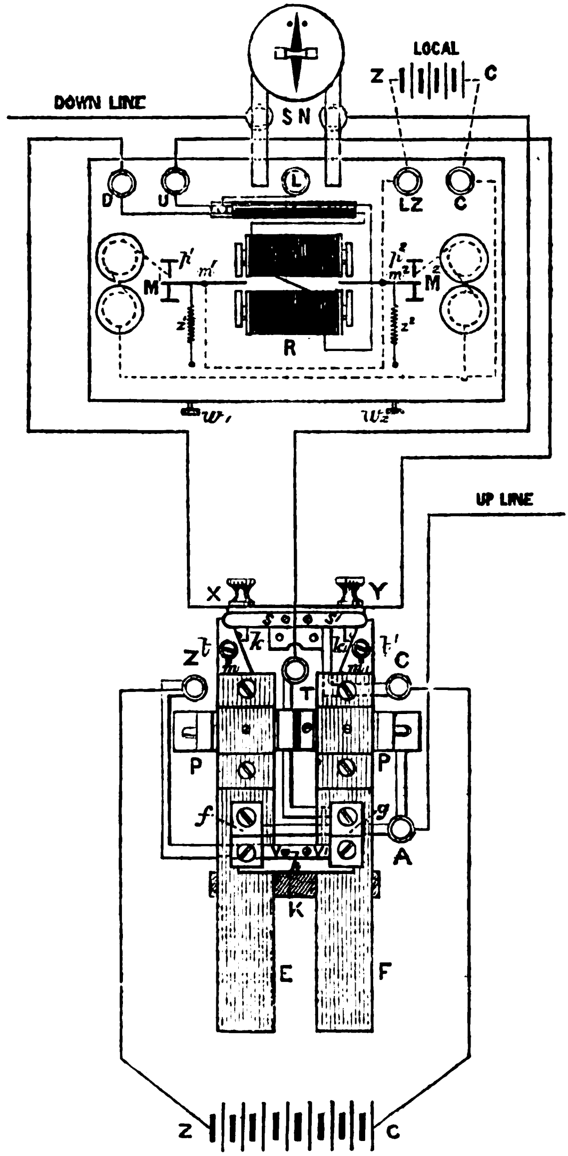


Fig. 14.

with terminal T, and through the dial, S N, with the "Down" line. The Copper pole, C, becomes connected through the end of the spring, s^1, with the prolongation, t^1, thence through the right-hand hinge block with terminal A and the "Up" line; thus the direction of the current is reversed.

When signals are being received on the instrument thence through the electro-magnet, R, and out at terminal U to terminal Y of the tappers; from thence it goes to k' and by the tongue, t^1, through the right-hand hinge block to terminal A and the "Up" line. Thus the outgoing currents pass through S N only, and the incoming currents through S N and through the electro-magnet, R.

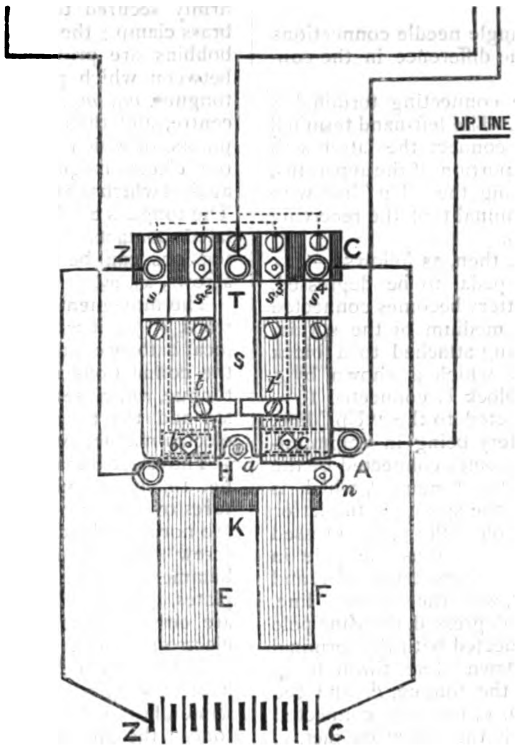

UP LINE
Z
C
T
S
H
A
K
E
F
Z
C

FIG. 15.

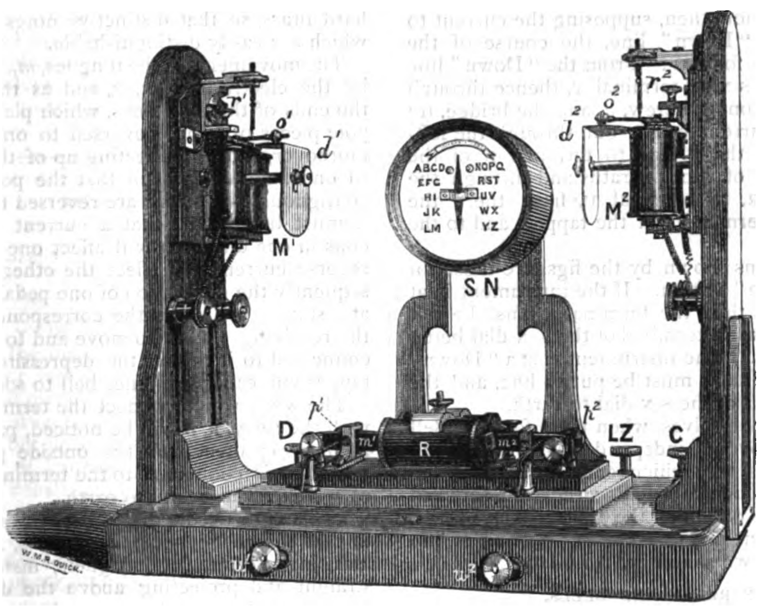

ABCD
NOPQ
EFG
RST
HI
UV
JK
WX
LM
YZ
SN
D
R
LZ
C
M'
M²

FIG. 16.

The connections for HIGHTON'S "TAPPERS" are shown by fig. 15.

As compared with the single needle connections shown by fig. 8, Art. II., the difference in the connections is as follows :—

The short piece of wire connecting terminal A with the nut, *n*, is removed. The left-hand terminal of the bridge, H, is used to connect the latter with terminal D of the receiving portion of the apparatus, and terminal A, besides having the "Up" line wire connected to it, has also terminal U of the receiving apparatus connected thereto.

The *action of the tappers* is, then, as follows :—

Supposing the left-hand pedal to be depressed, then the Zinc pole of the battery becomes connected to terminal A through the medium of the spring, s^1, the screw, *b*, and the spring attached to a block underneath the pedals, and which is shown by *g*, fig. 7, Art. II.; this latter block is connected to A. The Zinc pole is thus connected to the "Up" line. The Copper pole of the battery being in communication with the spring, s^2, becomes connected by the medium of the latter with the tongue, *t*, which is now in communication with the spring, S, the latter having been, by the depression of the pedal, pressed away from the contact screw, *a*; thus the pole in question becomes connected with the terminal T, and thence through the dial, S N, with the "Down" line.

If the right-hand pedal be depressed, the Zinc pole of the battery becomes connected with the terminal T, the dial, S N, and the "Down" line, through the medium of the spring, s^3, the tongue, t^1, and the spring, S. The Copper pole, C, becomes connected through the spring, s^4, with the screw contact, *c*, and thence by the spring underneath the pedals with terminal A and the "Up" line; thus the direction of the current is reversed.

When signals are being received on the apparatus from another station, then, supposing the current to enter from the "Down" line, the course of the current will be as follows :—From the "Down" line through the dial, S N, to terminal T, thence through the spring, S, to contact screw, *a*, and the bridge, H; from there the current passes out through the left-hand terminal of the bridge to terminal D of the receiving portion of the apparatus and through the electro-magnet, R, to terminal U, from there the current goes to terminal A of the tappers and to the "Up" line.

The connections shown by the figs. are those for an "Intermediate" station. If the instrument is at an "Up" station, then the terminal A must be put to earth, the left-hand terminal of the S N dial being connected to line. If the instrument is at a "Down" station, the terminal A must be put to line, and the left-hand terminal of the S N dial to earth.

The tappers, themselves, when used for the Bell instrument are covered independently by a wooden case with a glass top, which encloses all but the front part of the ebonite pedals; they are screwed down to the table on which the apparatus is placed, and are set in front of the receiving portion of the apparatus, which we shall now consider.

"THE RELAY AND BELLS."

The receiving portion of the apparatus is shown in general plan by the upper portion of fig. 14, and in perspective by fig. 16.

The relay, R, which is actuated by the incoming current, consists of two electro-magnet bobbins firmly secured to the base of the apparatus by a brass clamp; the ends of the cases of each of these bobbins are provided with soft iron pole pieces, between which play two permanently magnetised tongues, m_1, m_2; these tongues are hinged at their centre, and their outer ends play between contact points, of which p_1 and p_2 are in connection with the electro-magnets, M_1, M_2; the other contacts, against which the tongues normally rest, are insulated. The tongues are held in position against these insulated contacts by means of springs, z_1, z_2, whose tensions can be adjusted by means of the thumb screws, w_1, w_2.

The movements of the tongues over to the contact stops, p_1, p_2, it will be seen, closes the circuit of the local battery connected to terminals Z and C through the connections shown by the dotted lines; the tongue, m_1, closes the circuit of the electro-magnet, M_1, and the tongue, m_2, closes the circuit of the electro-magnet, M_2.

The electro-magnets, M_1, M_2, which are seen in fig. 16, are provided with ordinary hinged armatures over their pole faces; these armatures, which are normally held by adjustable springs against the screw stops, r_1, r_2, have fixed to them the small hammers, o_1, o_2, which strike the bells, or rather plates, placed close to them, when the armatures are either of them attracted by the action of the electro-magnets.

In the earlier forms of the Bell instruments the hammers, o_1, o_2, struck against "Bells" (hence the name of the instrument), the bells being of different tones; the ringing sound of the metal was, however, found to be objectionable, and metal plates were substituted which give out "dead" sounds: these are very satisfactory to read from. The left-hand plate is of steel and the right-hand plate of hard brass, so that distinctive notes are given out which are easily distinguishable.

The movements of the tongues, m_1, m_2, are effected by the electro-magnet, R, and as the polarities of the ends of these tongues, which play between the pole pieces of R, are reversed to one another, and, moreover, as the connecting up of the two bobbins to one another is such that the polarities of the contiguous pole pieces are reversed to one another, it must be evident that a current traversing the coils in one direction will affect one tongue, and a reverse current will affect the other tongue; consequently the depression of one pedal of the tappers at a station will cause the corresponding tongue at the receiving station to move and to work the bell connected to it, whilst the depression of the other tapper will cause the other bell to sound.

The wires which connect the terminals, D and U, with the relay, R, it will be noticed, pass through the lightning protector, *l*; the outside portion of this protector is connected to the terminal L, by means of which it can be put to earth.

The single needle dial is simillar in construction to that shown by figs. 3, 4, 5, and 6, Art. I., but the inducing permanent magnets, instead of being straight and projecting above the dial, as in the figs. referred to, are bent round, so that the whole can be covered with a round brass case, as in fig. 16.

Faults.

Although there are several moving parts in the

Bell instruments, yet the faults to which the latter are liable are not numerous.

The screws on which the tongues, m_1 m_2, turn, may cause faults either from being screwed up too tight, so as to prevent the tongues from moving, or from being too loose, and thus rendering the contacts uncertain. The magnet bobbins are liable to become shifted, and should therefore be very firmly clamped down.

If the plates against which the hammers, o_1, o_2, strike are not screwed firmly they may slip down after a time, and allow the armatures of the electromagnets, M_1, M_2, to touch the pole faces, this will cause the armatures to stick and signals to be missed.

The tongues, m_1, m_2, may become demagnetised; this can be ascertained by removing them, and seeing whether they will support their own weight when touched against a piece of iron; if they will not bear this test they should be re-magnetised.

The Bell, like other instruments, is liable to a variety of faults, but these are usually of such a nature as can at once be detected, since all the parts are easily got at.

The only fault which may not be apparent, is contact in the lightning protector—which short-circuits the relay, R; this fault may be detected by connecting the battery wires direct on to terminals D and U and seeing whether the relay tongues respond.

The coils of the relay are wound to a total resistance of 200 ohms, and when carefully adjusted the tongues will work properly with a current of about 3·3 milliwebers. The bell magnets are each wound to a resistance of 40 ohms, and give a good sound with a current from a 10-cell Daniell battery. The coils of the single needle dial have a total resistance of 200 ohms, and the needle should deflect up to the stops with a current of 3·3 milliwebers.

The number of Bell instruments in use in the postal service is over 250. It is the most rapid form of hand-worked apparatus employed, but from its somewhat complicated construction it is not likely to be more extensively used than it is at present, though in the hands of skilled operators it does excellent work.

Reviews.

Lightning Conductors, their History, Nature, and Mode of Application. By RICHARD ANDERSON, F.C.S., F.G.S., Member of the Society of Telegraph Engineers. London: E and F. N. Spon.

JUDGING from the long list of books and pamphlets dealing more or less with the subject of lightning conductors, and given by Mr. Anderson at the commencement and end of his work, it might be imagined that but little more could be added to the existing stock of knowledge regarding the theory and practical construction of the lightning rod; such, however, is not the case, and Mr. Anderson's excellent new book will really prove a most valuable addition not only to a scientific library but also to the library of every architect or other person concerned in the construction of every kind of building.

The amount of ignorance that exists on the subject of lightning conductors is very great; the means that have existed for obtaining information regarding the same has hitherto been equally great. No good English work, with the exception of the one now before us, has been written. This want has now been supplied, and well supplied, too.

The amount of damage effected by lightning in this country alone is very considerable, and not a year passes but we hear of a large number of buildings being struck and greatly damaged; in some cases the mischief done is irreparable. The destruction of ancient buildings inseparably connected with historical associations is in every case a deplorable disaster, and one which no amount of money will repair. Some of our finest ancient structures—Windsor Castle amongst others—are either totally or insufficiently protected from lightning, and may some day be witnesses to the folly or apathy of those to whom their preservation is practically entrusted. Every possible care is taken to protect such structures from fire, and large sums are spent for the purpose, but the few pounds necessary to erect lightning conductors are either grudged or are not expended from pure ignorance of the importance of the means of protection.

In the commencement of his work, Mr. Anderson has written in an entertaining manner an account of the early discoveries made on the subject of electricity, in the narration of which the name of the immortal Franklin is, of course, prominently noticed; how thoroughly this philsopher grasped the truth of the identity of electricity and lightning is well pointed out, and we see that from the date at which this fact was made manifest, namely, at the middle of the last century, the history of lightning conductors practically commences.

The first lightning conductor ever constructed was set up by Franklin himself at his house in Philadelphia. The spread of the system was at first slow, in Europe notably so; in many cases personal enmity checked the progress; an ignorant priesthood, which scented heresy in an attempt to draw lightning from the clouds, for a long period waged war against the heretical rods, but as time went on, and the protective effects of the rods were seen, the opposition ceased, and the disputes took the form of controversies on the proper terminations to give to the protectors, *i.e.*, whether points or balls were most effective. The controversies ran so high that they resulted in the resignation by Sir John Pringle of the Presidency of the Royal Society. Subsequent experiments proved conclusively the superiority of the pointed conductor.

In Chapter V., Mr. Anderson deals with the subject of metals as conductors of electricity, and he gives tables of the comparative values of the various metals as determined by different physicists; the want of agreement is considerable, though the superiority of copper is in all cases agreed upon.

The conductivity of the material employed for the rods is easily determined previous to the fixing of the same, but after their erection their continuity requires testing to detect faulty joints, &c.; for this purpose Mr. Anderson has designed a simple and handy instrument, which consists of a three-cell battery of low resistance, a galvanometer, and a set of three resistance coils. Five keys are attached to the apparatus; by depressing one key the battery is put through the galvanometer direct, another key closes the circuit through a known resistance, a third key interposes a higher resistance, and a fourth key inserts a resistance of a still greater value,

whilst the fifth key connects the battery and galvanometer to the terminals to which the line to be tested is connected. The galvanometer and keys are fixed to the cover of the case containing the battery and the resistance coils. The case has also sufficient space inside for a bobbin of insulated connecting wire. The whole arrangement is very portable, and well adapted for the purpose for which it is designed. The simple method of testing by comparing the resistance, whose value is to be determined, with the resistance coils, is, we think, very suitable for the purpose, and is much better than any more elaborate arrangement, such as a Wheatstone balance. Very accurate tests are not wanted, but reliable and easily made ones are, and this Mr. Anderson's arrangement undoubtedly ensures.

At the present day we imagine there are but few persons who doubt the correctness of the principle of the lightning rod; if there are any who do, the case mentioned by Mr. Anderson of the village church of Carinthia, in Austria, must convince the most incredulous. This village church was unceasingly struck in the course of the seventeenth and eighteenth centuries by lightning, which sometimes battered in the roof, sometimes broke down part of the steeple, and often flew in at the window on one side and out at the other. The lightning came again and again, and in the summer of 1780 a flash from the clouds, more violent than any preceding one, demolished the entire steeple. The Orsini family erected another steeple. But the lightning visited it as before, on the average five or six times a year, doing so much damage that the whole church had to be taken down in 1787, being found in ruins. Once more the proprietors of the village built a new church on the old ground; but this time they placed a lightning rod upon it, and no further damage ensued.

In *every* case in which a lightning conductor has failed in its purpose the result is due to faulty construction. There is *no* case on record, says Mr. Anderson, in which a really efficient lightning conductor, properly placed and with its terminal in technically so-called "good earth," did not do its duty; and, as the author most logically observes, "it may well be asserted, can no more fail to give protection than an efficient drain-pipe can fail to carry off the water upon the roof. Although," observes the author, "the electric force is neither a 'current' nor a 'fluid,' often as it is so described, still the analogy holds good so far as the one here given between the drain-pipe and the conductor. And the reason is clear enough. The water, in running down a hollow tube, obeys simply the law of gravity; but no less immutable than this is that which governs the movement of electric force. As the water has no choice but to follow the channel made for it under the guidance of experience and mathematical calculation, so has the emanation of the electric energy no option but to pursue the path which scientific investigation has shown it always to take."

(To be continued.)

International Telegraph Convention, with London Revision of Service Regulations and Tariffs, 1879. Translated by ALFRED BRASHER, 55, Parliament St.

WE have received a copy of this work, which contains the Service regulations as revised by the London Conference held last year. The original text is in French, but being now translated into English by Mr. Brasher, and the whole well printed, the book is a useful reference work for all who have to deal with, or require information concerning, the subject in question.

THE ATTORNEY-GENERAL *v.* THE TELEPHONE COMPANY (LIMITED).

(Before the Lord Chief Baron and Justice Lopes.)

ON February 9th, in this case, Mr. Macrory, on behalf of the defendants, asked their lordships for liberty, on or before Wednesday, February 11th, to file affidavits in answer to those filed by the Attorney-General. There was an undertaking given that the affidavits should be filed by February 3rd. Certain negotiations were entered into which only terminated a few days ago, and pending these negotiations the defendants did not proceed with the affidavits. The negotiations had now been broken off, and the defendants asked their lordships for further time in consequence.

The Lord Chief Baron: I would merely suggest, Mr. Attorney, that, if it does not interfere with your other engagements, a case of such importance, affecting public and private rights, should be heard before us once and for all.

The Attorney-General: I am quite ready that such a course should be adopted, but I am anxious to protect myself against any accusation that I had been guilty of delay in the matter.

The Lord Chief Baron: I am sure no such accusation will be made against you, Mr. Attorney-General. You have the power to call upon us at any time to hear the cause, and we will then appoint a day for it to be heard before three judges.

The Attorney-General: These remarks will also, I apprehend, apply to the case of the Edison Telephone Company, which will stand over until all the affidavits have been filed and the evidence is completed.

The Lord Chief Baron: Certainly.

Notes.

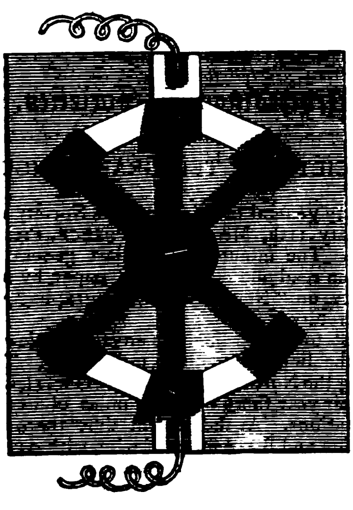
MESSRS. THEILER & SONS write us, respecting the "tapper" key described in our issue for the 15th ult. (fig. 1), that "Mr. Theiler, senior, designed two patterns of single needle tappers for Mr. Culley (then engineer-in-chief) in 1870: one in April, the other in June. The latter pattern was adopted, and Mr. Theiler subsequently (in July, 1870) put in a claim for the designing of the tappers, which was accepted and paid in due course." Thus the credit of the design would appear to be due to Mr. Theiler.

THE committee appointed by the French Minister of Public Instruction has awarded the *Prix de Volta*, 50,000 fr., to Graham Bell.

WE may mention that the General Telephone Agency Company, Limited, who are working the Gower tele-

phone in London, do so under license from the (Bell) Telephone Company.

THE GOWER TELEPHONE.—As we mentioned in our last issue, the Gower Telephone Company are to use a microphonic transmitter for working their apparatus. The arrangement of this transmitter is shown by the fig.; it consists of 6 microphones formed of 6 carbon rods, the outer ends of the latter are set in carbon blocks fixed to metal plates, to which the connecting wires are attached, as shown; the 6 inner ends rest in a single carbon block on the centre of the arrangement. The whole is secured on a wooden board against which the sound waves impinge. The system in fact differs



but very slightly from Crossley's microphonic transmitter which was described in the number of the Journal for May 1st, 1879.

A CONTRACT for laying a submarine cable across the Gulf of Mexico, connecting the United States with the Mexican Republic, has been approved by the Mexican Congress.

CAOUTCHOUC.—The German Society for the promotion of Industry offers a gold medal and £150 for a substitute for caoutchouc, and the same premium for a substitute for gutta-percha.

THE POST OFFICE AND THE TELEPHONE.—The report circulated by the *Western Morning News*, "that an arrangement has been entered into between the Post Office and Bell's Telephone Company, by which proceedings against the Company will be abandoned," is, we believe, without foundation.

IN a letter from Professor Rossetti to A. Cornu, published in *Comptes Rendus* of November 10th, 1879, occurs the following:—"The electric light includes, as is well known, two sorts of radiations—viz., the rays emitted by the incandescent carbons, and those emitted by the voltaic arc, which springs between the polar extremities of the carbons. The former give a white, the other a purple blue light; the resulting light is bluish white. The two polar extremities have temperatures very different the one from the other. The number of degrees which expresses their temperature can be deduced from the formula—

$$y = m\,T^2\,(T - \theta) - n\,(T - \theta),$$

supposing that the carbons have the maximum emissive power. The voltaic arc has very little thermal emissive power comparable to that of the pale blue flames of the Bunsen burners. Its temperature can also be obtained with the aid of the preceding formula, provided that the value of the thermal emissive power of the voltaic arc relative to its thickness be introduced. A great number of experiments have given the maximum temperature of about 3,900° C. for the positive, the temperature of about 3,150° for the negative polar extremity of the carbon. For the voltaic arc, which springs between these two extremities, the temperature was always about 4,800°, whatever the thickness of the arc and the intensity of the current."

IN a letter to the *English Mechanic* a correspondent says:—"I suppose most of the readers of this, who have to do with dynamo machines in the production of the electric light, have found a difficulty at times in overcoming the firing of the copper combs, caused often by impurity in the carbons, or faulty lamp. On one occasion, by mere accident, I found that freely chalking the revolving plates, not only stopped the local fire, but increased the steadiness of the light; and I now have these well chalked each day before starting the machine."

"DYNAMO MACHINES" *versus* "BATTERIES."—The *Scientific American* for January 31st contains an illustrated account of a system of dynamo-electric machines which are being applied by the Western Union Telegraph Company in their New York office for telegraphic purposes in the place of the ordinary batteries. "There are at present," says the journal referred to, "on the top floor of the Western Union building 14,300 gravity battery elements, and in an adjoining building there are 4,600 bichromate of potash elements, all of which are to be replaced by electric machines, and the electric current will be generated by the consumption of coal instead of zinc and acid. It is not a new idea to use machines for this purpose, but experiments in this direction, until quite recently, have not proved entirely successful. The new system of current supply, which has been adopted by the Western Union Company, has for the last few months been thoroughly tested in San Francisco, to the satisfaction of telegraph engineers and operators, and recently a set of machines have been put on trial in the battery room of the Western Union building with satisfactory results. The apparatus consists simply of a number of Siemens machines connected in series, and having their field magnets excited by a current supplied by a single Siemens dynamo-electric machine.

"All efforts formerly made in this direction sought to accomplish the object by using a single high tension machine. The potential is now obtained by connecting one commutator brush of one machine with the brush of opposite polarity of the next, and so on, and a current of any desired potential may be had by taking it off from the different machines in the series. A current taken from the first machine in the series will have a low tension; that taken from the second machine will have a higher tension, and so on.

"The electromotive force of the first machine in the series is 50 volts; in the second, 100 volts; in the third, 150 volts; in the fourth, 250 volts.

"There are three sets of the machines and engines—two sets for working the 360 wires radiating from the Western Union building and the cables of the Gold and Stock Telegraph, and one for reserve. The current is equally well adapted to the quadruplex and to the printers of the Gold and Stock Telegraph. These machines and their engines will not occupy a tenth of

the room now devoted to batteries, and a single engineer can attend them all.

"When this system is thoroughly inaugurated, the batteries will all be removed, relieving the battery room floor of a weight of 60 tons, that being the difference between the weight of the batteries and that of the new plant. The current generated by the machines is to be used for all of the purposes for which battery power is now used, such as annunciators, call bells, small motors, &c., besides working the main lines and local circuits, and in addition to this the Western Union building is to be illuminated by electricity at an early day. The Siemens machine is preferred to any other."

We may remark that a patent was taken out in this country in the year 1878 by Mr. Henry Wilde, for the application of dynamo machines to telegraphic purposes.

A correspondent of the *Athenæum* says that Dr. Schwendler, electrician to the Government of India, finds, as the result of experiment, that a current from a dynamo-electric machine is better in every respect for telegraphic purposes than the current from a galvanic battery. He produces a strong current from the machine; one portion thereof, at night, can be used as light, or in daytime may be employed in pulling punkahs, exciting currents of air, and other mechanical operations. Besides all this, weak currents may be drafted from the main current, and supplied to telegraph offices, as was demonstrated in October last, when messages were telegraphed from Calcutta to Agra, 850 miles distant. The weak signal current was obtained by tapping the current which was maintaining a powerful electric light. No diminution of the light was perceptible, the small stream tapped off being not more than ·004 of the main current. In this way a telegraph office may be lighted and supplied at the same time with signal power, and the costly and cumbersome galvanic apparatus may be got rid of.

During the course of 1879, three new telegraph lines have been constructed and opened for service by the Government Administration of the Persian telegraphs, viz., Recht to Enzeli, 20km.; Semnan to Firouzkouh, 70km.; and Ispahan to Kerman, 634km.; total, 724km. This extension of the system has led to the opening of ten new offices, and an increase of 13 in the number of instruments, and of 47 in new operators.

Electricity in Mines.—M. Jutier, a French engineer, after examining the action of electricity on dynamite, has come to the conclusion that the improvements effected in the construction of machines for generating electricity, in the manufacture of conducting wires with isolating envelopes, and, above all, in that of trains, have rendered the firing of shots in mines by electricity quite practicable. They have removed the inconveniences and difficulties of detail which prevented the success of the first attempts, undertaken at a period already ancient. With the employment of dynamite, this precious auxiliary of mining works, the firing by electricity diminishes the cost of the explosions. This advantage disappears when powder is used, but it is more than compensated by the simultaneous explosion of several shots. One may return immediately, and in security, to the scene of the shots; the smoke and gas produced by the combustion of ordinary tinder are avoided. In any case this process suppresses a too frequent cause of accidents, by permitting the firing of the shots when the workmen are removed from the spot, and even when there is no one in the pit or mine. There is in that, most certainly, a most important consideration, above all when the sinking takes place in a mine where fire-damp exists.

The New Inman Line Steamship, which is being built by the Barrow Shipbuilding Company, is to be named the *City of Rome*. It is proposed to fit her with the electric light, after the success which has attended the introduction of that light on the *City of Berlin*.

The Electric Light in Shipbuilding.—Messrs. Robert Napier and Sons experimented with the electric light, during the morning and evening hours, in lighting up the new store-ship which they are at present building for the Admiralty. The test proved so satisfactory that the firm have erected a second machine and lamp for use in the building of the large new steel steamer *Parisian* for the Montreal mail service of Messrs. J. and A. Allan. Recently both lights have been in use for nearly two and a half hours in the morning and two hours in the evening. The two lights in the open yard are very brilliant, and quite sufficient for working with.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

An ordinary general meeting of this Society was held on February 11th, Mr. W. H. Preece, President, in the chair. The minutes of the last general meeting having been read and confirmed, a paper by Mr. A. T. Maginnity, on "New Zealand Telegraphs," was read by the secretary.

The first telegraph line was erected in New Zealand in 1862, the line being eight miles long. The cable connecting the North and South Islands was laid in 1866. In the latter year there were 699 miles of line erected, with 13 stations. At the present time there are 3,345 miles of line and 8,445 miles of wire, with 943 stations, being an increase of 10 per cent. on the former year. The telegraph staff consists of 801 persons, with salaries varying from £120 to £375 a year. The engineering staff consists of 5 inspectors and 2 sub-inspectors, with 50 linemen. The duration of faults seldom exceeds one hour. Varley's brown ware insulators are used, which, however, are being largely replaced by those of white porcelain. The majority of the poles were originally earth wired, but these wires have now to a great extent been removed as they caused a considerable leakage on the lines. The instruments are chiefly sounders worked by Daniell batteries, but Fuller's batteries are being used with great success. The instruments are worked on the open-circuit system. The lines are worked wholly by the Government, but an independent railway system is being organised. Telephones are coming into extensive use, and private lines with Siemens dial instruments are also worked. A system of fire telegraphs connecting the various fire stations, police stations, and Government offices, is in operation.

In the discussion which followed the reading of the paper:—

Mr. Preece stated that Mr. Floyd had adopted telegraph poles in New Zealand made out of old railway metals, the idea being suggested to him by a paper of Mr. David's which had been read before the Society describing the use of such metals on a telegraph line in Brazil.

A note on "The Durability of Iron Wires," was then read by Mr. W. H. Preece.

In 1844 a line of telegraph was erected between Nine Elms and Gosport, formed of a No. 8 wire. A portion of this wire between Bishopstoke and Botley was lately removed at the author's request by Mr. Goldstone, and this specimen was exhibited to the Society. This piece was 69·33 yards long, and on being measured and tested gave the following results:—

Diameter	175 mills.
Weight	16·268 lbs.
Resistance per mile at 60° F....	12·898 ohms.
Breaking strain...	1,189 lbs.
Stretch before breaking ...	15·5 per cent.
Twists in 6 inch length before breaking...	13½

The galvanising had entirely gone and the wire was very rusty, but in other respects, as the tests showed, the wire was in excellent condition after the 36 years' exposure.

In the discussion following the reading of the paper—

Mr. STEARNS and Mr. STROH drew attention to the brittleness of wire exposed to an impure atmosphere.

Mr. TREUENFELD said that the question of brittleness was purely a chemical one.

Mr. BELL stated that in his experience the purer the wire the better was the galvanisation and the longer would it resist the action of the weather.

Professor HUGHES stated that he had made some experiments with steel wires dipped for a minute in dilute sulphuric acid, this dipping rendered them quite brittle. With iron wire the dipping required to be as long as fifteen minutes to produce the same effect. This brittleness could be got rid of by heating the wires.

Mr. CHANDLER ROBERTS attributed the effect to absorbed hydrogen, but Professor HUGHES said that two wires plunged into water and having a current passed through them so as to generate oxygen and hydrogen gases on their surfaces did not become brittle by this process.

Mr. WILLOUGHBY SMITH stated that his experience with copper wires showed that the greater the purity the greater the durability.

A paper by Mr. A. Eden on "Morse Signalling by Magneto-Electric Currents," was then read by the secretary.

An ordinary Siemens A B C instrument transmitter was caused to transmit its currents through a relay and a high resistance, so as to cause the tongue of the relay to vibrate backwards and forwards between its stops. The transmitter was also connected to the tongue of the relay, and the stops of the latter were severally connected to the signalling keys of two circuits between Edinburgh and London. The action of the relay was thus to cause all the positive circuits to pass to one key, and all the negative to the other key, so that a rapid series of currents of each kind took the place of the battery current usually employed to work the circuits. The currents were rendered practically continuous by condensers connected in the circuits; by this means the latter were worked very satisfactorily, and demonstrated the practicability of the idea of employing magneto machines for working telegraph lines.

In the discussion which followed the reading of the paper—

Mr. PREECE pointed out that in 1865 Mr. Varley had tried Wilde's magnetic machines for working telegraph lines, and in 1872 Mr. Culley had tried the Gramme machine for a similar purpose; the experiments, however, were not satisfactory. More recently Wilde* had patented a system for effecting the same object, and Schwendler had made experiments in the same direction. In America, the Western Union Company had largely adopted magnetic machines to replace batteries, but Mr. Preece stated that to do the same in England would effect no economy, as the battery power in the Postal service was very economical, not costing one-tenth of what it did in America, where the system employed was extremely wasteful.

A paper, by Mr. C. Wilson, on "Compensating Induction in Parallel Wires," was next read by the secretary. The author observed that Professor Hughes had remarked, that Mr. Wilson's system* could only be applied to two lines; but the paper explained that it was equally adapted to three or more wires. For two wires, a condenser and resistance was placed between the two balance resistances; but, for three wires, a condenser and resistance was placed between the balance resistances of wires 1 and 2, of 1 and 3, and of 2 and 3, and so on for any number of wires.

In the discussion which followed the reading of the paper, Professor HUGHES pointed out that, for a large number of wires, Mr. Wilson's system would require a very great number of condensers and resistances. Professor AYRTON, Mr. STEARNS, Professor PERRY, and Mr. PREECE also took part in the discussion; at the conclusion of which, the usual votes of thanks being proposed and seconded, the meeting adjourned till Feb. 25th.

THE PHYSICAL SOCIETY.

THE annual *conversazione* of this Society was held on the evening of Saturday, February 7, in King's College. The Museum of King George III., the Wheatstone Laboratory, and other halls of the college were occupied by a fine display of physical apparatus and artistic furniture, including numerous relics of Sir Charles Wheatstone. There was a large number of ladies and gentlemen present, and during the evening selections of music were played by the Musical Association of the Royal School of Mines. The apparatus was peculiar to the whole range of physical science, and was furnished in part by the college and in part by the various instrument makers and electric engineers of the metropolis. The Telephone Company and the British Electric Light Company contributed telephones and electric lamps, and Herr Faber exhibited his ingenious speaking machine.

New Patents—1880.

71. "Improvement in the apparatus or means for signalling upon, and for operating switches, signals, and other moving parts connected with lines of railway." S. J. F. DAY. (Communicated by J. S. Williams.) Dated Jan. 7.

158. "Apparatus and arrangement for telephonic and microphonic purposes." L. J. CROSSLEY. Dated Jan. 14.

203. "Improved apparatus for developing the electric light." J. CLARKE. Dated Jan. 16.

231. "Submarine electric lanterns." F. W. HENIKE and G. LANG. Dated Jan. 19.

250. "Electric lamps." J. W. SWAN. Dated Jan. 20.

296. "Electric telegraphs." W. C. BARNEY. Dated Jan. 23.

303. "Improvements in telephone signal apparatus, and in keeping clocks in unison." W. MORGAN BROWN. (Communicated by G. H. Bliss.) Dated Jan. 23.

315. "Improvements in and relating to apparatus for generating, controlling, and utilising electricity for lighting and other purposes." W. R. LAKE. (Communicated by E. J. Houston and E. Thomson.) Dated Jan. 23.

350. "Electric lamps." J. P. C. DE PUYDT, J. COUGNET. Dated Jan. 27.

351. "Improvements in telephones, parts of which improvements are also applicable to other electrical purposes." L. DAVIS. (Communicated by E. Marx, F. Aklemm, J. Kayser, and A. G. Tisdel.) Dated Jan. 27.

* See note.

* *Telegraphic Journal*, July 15, 1878.

404. "Improved means and apparatus for effecting electrical connections for telephonic communication." G. WESTINGHOUSE. Dated Jan. 29.

409. "Improvements in and relating to switch apparatus for telegraphic and telephonic purposes." W. R. LAKE. (Communicated by J. A. Watson.) Dated Jan. 29.

436. "Apparatus for registering or recording telegraphic or other signals." C. Mc G. BATE. Dated Jan. 31.

455. "Lamps for electric lighting." S. H. BLAMIRES. Dated Feb. 2.

471. "Telephonic apparatus." H. H. LAKE. (Communicated by G. L. Anders and J. A. Watson.) Dated Feb. 3.

478. "Electro-magnetic and dynamo-electric machines." J. MORGAN. (Communicated by N. Glouchoff.) Dated Feb. 3.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

1668. "Improvements in portable magnetic appliances, in conjunction with medicinal substances for the cure of diseases." THOMAS WELTON. Dated April 28th. 4d.

1969. "Improvements in and connected with electric light apparatus or lamps." ALFRED LONGSDON. (A communication from abroad by Alfred Krupp, of Essen.) Dated May 16th. 6d. The object of this invention is to ensure a suitable automatic periodical regulation of the distance of the carbon points or other electrodes used in electric lamps. The core of an electro-magnet is connected to a lever which is connected to the lower carbon-holder, and also by a rod or other connection to a clamping or pinching appliance or holder for the upper carbon. A spring in connection with the lever is so arranged as to counteract the force of the electro-magnet. When the circuit is complete, and the carbon points close together, the lower carbon is, by the electro-magnet, drawn down, and the upper carbon held fast by its clamp or holder, which may be an electro-magnet or an inclined piece acting against a peg, or cam, or piece which presses against the upper carbon or its holder, a helical spring tending to force the peg back. The voltaic arc now appears in its full power, but as the carbons are consumed the current is weakened; the spring at last becomes more powerful than the electro-magnet, and lifts the lever with the lower carbon, at the same time the grip on the upper carbon or its holder is released, so that the carbon drops down upon the lower carbon; the current is thereby strengthened so that the electro-magnet overpowers the spring and draws the lower carbon down, at the same time gripping the upper carbon or its holder. The regulation takes place about every three minutes, and is so quick that it is imperceptible.

1971. "Improvements in lighting by electricity." A. M. CLARK. (A communication from abroad by Nicolas Emile Reynier.) Dated May 16th. 8d. Consists of an automatic switching arrangement, by placing change lamps in a derivation of the principal current, and in inserting in the derivation appropriated to each of these lamps, except the last one, electro-magnets or solenoids, which open the derivations of the succeeding lamps when they are magnetised, and close them when they are demagnetised. (*Not proceeded with.*)

2011. "Electro-magnetic pens." JOSHUA MOSES JOSIAS. Dated May 20th. 6d. Consists of an electro-magnetic puncturing pen, with a puncturing needle and electro-magnet and battery, so that they form one compact portable instrument. Also of a suitable ink-roller for use with same.

2060. "Apparatus for electric lighting." ADAM FETTIPLACE BLANDY. Dated May 23rd. 6d. Consists of an electro-magnetic governor for regulating currents of electricity in the branches of a divided circuit, so as to permit of electric lamps being used in the said branches. The governor is formed of a piece of iron called the core, round which two or more insulated wires are wound together parallel to each other.

2111. "Electric lighting apparatus." W. R. LAKE. (A communication from Jules Puvilland and Toussaint Raphael.) Dated May 27th. 6d. This invention relates to improved electric lighting apparatus in which revolving annular carbons are employed, these carbons being of considerable length, but occupying only a small space. The said carbons revolve in proportion to the wearing away of the points between which the light is developed. An electro-magnet, traversed by a current at the entrance of the latter into the apparatus serves to produce the separation of the carbons if they come too closely together.

2199. "Improvement in lighting by electricity." ISIDOR FURSTENHAGEN. (A communication from abroad by Louis Siemens, of Charlottenburg.) Dated June 3rd. 2d. Is intended to produce a steady-burning electric light of extreme intensity, in conjunction not only with strong, but also with weak currents such as it has hitherto been impossible to utilise for illuminating purposes. In order to effect this object, a round or prismatic carbon tube is employed, through which is placed a wick, made by preference of glass or any other suitable vitreous substance which, in consequence of its being capable of evaporation in a high temperature, causes the flame-arc to be a good conductor of electricity, and to be so highly developed as to allow the intensely illuminating points of the two pieces of carbon, even when the currents are comparatively weak, to be placed at such a distance from each other as to maintain the illuminating power whilst obviating the occurrence of flickering. (*Not proceeded with.*)

2211. "Improvements in telephones." H. C. DUMONTIER. Dated June 4. 2d. Consists of a horse-shoe magnet, one face of which serves to receive the telephone, the other face, the call. This call is constructed of a magneto-electric apparatus formed of two bobbins turning in front of the magnet; the current is collected by means of a commutator, and sent into any ordinary bell arrangement. (*Not proceeded with.*)

2301. "Apparatus for electric lighting." R. WERDERMANN. Dated June 10. 6d. Consists of several modifications of Mr. Werdermann's previously-described lamp; * notably a balance adjustment of the upper carbon which is pivotted.

2322. "Electric lamps." C. D. ABEL. Dated June 11. 2d. Consists of two carbon electrodes carried by two pistons, plungers, or floats contained in two closed vessels filled with liquid in communication with each other, the relative heights of the liquid in the vessels, and the weight of the pistons and arms projecting therefrom carrying the carbons, being so proportioned that the piston carrying the upper carbon will tend to descend in its vessel, causing the liquid to flow therefrom into the other vessel, and thereby raising the second piston with the lower carbon. (*Received provisional protection only.*)

2340. "Electrodes for electric light." A. M. CLARK. (A communication from C. J. PIERRE DESNOS.) Dated June 12. 2d. Consists of carbons made cylindrical with iron or other metal rods down their centres. Also the entire surface of the electrodes are coated with a

* *Telegraphic Journal*, Nov. 15th, 1878.

material impervious to the surrounding air, incombustible, but a good conductor of electricity. (*Received provisional protection only.*)

2705. "Mariner's compasses." W. R. LAKE. (A communication from Stephen Longfellow.) Dated July 3rd. 6d. Relates to certain improvements in methods and devices for preventing the deviation of the compass needle from its proper direction caused by the effects of local attraction.

3479. "Electric signalling apparatus for railways." W. ROBINSON. Dated Aug. 29. 8d. Has for its object, chiefly, the automatic operation of electric signals on railways by means of passing trains, the rails of the track being used as principal conductors of the electric current. The track is divided into sections insulated from each other. The battery has its poles connected to the opposite rails of the track at one end of the section, the magnet which controls the operation of the signal being similarly connected at the opposite end of the section. The current from the battery keeps the magnet magnetised until a train comes on the section, when the wheels and axles, by short-circuiting, cut off the battery current from the magnet, which is thus demagnetised, and the position of the signal thereby changed, thus indicating to a following train the danger ahead. The circuit, it will be observed, is constant.

City Notes.

Old Broad Street, Feb. 12th, 1880.

ANGLO-AMERICAN TELEGRAPH COMPANY.—The ordinary general half-yearly meeting of the proprietors was held on February 6th at the City Terminus Hotel, Cannon Street, Lord MONCK, the chairman, presiding. The report stated the total receipts from the 1st July to the 31st December, 1879, including a balance of £11,300 12s. 7d. brought over from the last account, amount to £397,426 16s. 4d., being an increase in the traffic receipts, as compared with the corresponding period last year, of £91,731. The total expenses of the half-year, including income tax, repair of cables, &c., as shown by the revenue account, amount to £59,765 19s. 7d. The directors have, before declaring the net profits, set apart the sum of £140,000 to the renewal fund, leaving a balance of £197,660 16s. 9d. One quarterly interim dividend on the ordinary stock, at the rate of 6 per cent. per annum, free of income tax, was paid on 1st November last, absorbing £105,000, leaving a balance of £92,660 16s. 9d., out of which the directors recommend the proprietors to declare a final dividend of 1¼ per cent., free of income tax, amounting to £87,500, making a total distribution for the year ended the 31st December, 1879, of 5 per cent. upon the consolidated stock of the Company, 6 per cent. upon the preferred ordinary stock, and 4 per cent. upon the deferred ordinary stock; and leaving a balance of £5,160 16s. 9d. to be carried forward to the next account. The SECRETARY (Mr. John Grant) read the notice convening the meeting and the minutes of the last meeting, which were confirmed, the report being taken as read. The CHAIRMAN: "Gentlemen, the natural division of the subject which I have to bring before you coincides with that which prevails in a larger and more important annual meeting in which I took some concern yesterday—viz., it divides itself naturally into our domestic and foreign relations. With regard to our home work, the report, I think, has made it pretty plain that I have no need to tell you that it is eminently satisfactory. Your property is in a good condition, and your cables are working with their usual efficiency. Your income has, as you will observe, very largely increased within the last half-year, as compared either with the preceding half-year or with the corresponding half of the preceding year. We propose, as we stated at the last half-yearly meeting, to lay down a new cable this year between Ireland and America, and we have the pleasure to tell you that we are in a position to do that without asking you or the public for a farthing of the money. (Applause.) We propose, in addition to that, to lay down or to renew, as you will observe by the report, other portions of our system which have either worn out or become inefficient—I mean short cables connecting the island of Newfoundland with the continental portion of America, and this work it is absolutely necessary should be done in order to maintain the efficiency of our system. We propose to do that also out of the money in hand. Gentlemen, there were some doubts expressed at the last meeting, I think, about the propriety of laying down a new cable between Ireland and America this year. The argument used, as I recollect it, was that when a cable gets to the bottom of the sea it more or less deteriorates in quality, and therefore the longer, consistently with the efficient performance of your work, you can put off laying down a new cable the better. Well, now, gentlemen, no one is more ready than I am to admit the general soundness of that argument, but it must be taken with certain qualifications. In the first instance, the enormous increase of your traffic has rendered it absolutely necessary that you should keep at least three cables in full working. (Applause.) Our three cables are working and each performing their full share of work, but we must recollect that one of these cables is very nearly eleven years old, and without any disparagement to its condition we must be prepared for contingencies. (Hear, hear.) I will go no further than that. Gentlemen, there is another view of the matter, and my allusion to it shall be very short—viz., our foreign relations—and by that I mean to express what you are all aware of, that a cable has been laid down by a new French company. Now, gentlemen, the result of that will be a competition. A competition as, I understand, and as we have already announced, can only be carried on by a very considerable reduction of tariff. A very considerable reduction of tariff means nothing more than a very considerable increase of traffic, and in order to carry that increase of traffic, with a reduced tariff, as efficiently as you have done hitherto, you must be prepared with additional instruments for the working of the traffic. There is another view of the matter; sooner or later it must come to an arrangement, and the basis of that arrangement will depend mainly on the number of efficient cables, and our share of the profits arising out of that arrangement will depend very materially on the number of efficient cables that we shall have when that arrangement is made. (Applause.) I think, gentlemen, I need not trouble you further on that point, because I am pleased, from the indications of assent which I hear from all parts of the room, to find that you are convinced that we ought at once to exercise the power we have of laying down a new cable. (Applause.) We have made arrangements, or arrangements are in progress, for a new survey of the bed of the Atlantic, so as to obtain, if possible, a better resting-place for our new cable than has been afforded to those which have preceded it; a gentleman whom I see here also suggested that we should make experiments with reference to the coating of the cables. We have been engaged in that too, and we are in great hopes, from the turn things have taken and the result of the experiments we have made, that we shall be able to get a class of cable which will more effectually resist the deterioration of

whatever influences may be brought to bear upon it under the water than many that have yet been laid down. In fact, I may say, once for all, that with reference to this new cable we are doing everything we can to get the highest intrinsic security in the cable itself, and the best possible bed for it in the bottom of the Atlantic." The Chairman concluded by moving the adoption of the report. Sir DANIEL GOOCH seconded the resolution. The CHAIRMAN, in reply to shareholders, said that with regard to the reserve fund the powers given were unlimited, but the board had no notion of maintaining the contribution which had been made this half-year. It was an exceptional case, as they should have the very large outgoings he had already referred to. They had had very good reasons for not publishing the usual traffic returns, but they need not be in the least alarmed, as the traffic for January had amounted to a very tidy sum. (Applause.) Mr. Newton had referred to a monopoly, but he could assure the meeting that the Company had never had such a thing. (Hear, hear.) There had been an undertaking from the British Post Office, and a concession from the French Government, giving them any messages not directed to go by any other cable, and that monopoly, if it were one, had not been infringed in the slightest degree. Mr. Newton had asked why they did not make use of the advantages at their disposal by carrying messages at a low rate, and allowing their partner, the Direct Company, to carry special messages at a high rate? It would perhaps surprise him to hear that that was precisely the arrangement they had made. (Applause.) The "caving in" was not on their side. He had only said that these people had come and offered certain terms. As he had already said, these negotiations were still in progress, and the matter had better be left at present in the hands of the board. (Applause.) If it were possible, without prejudice to the interests of the company, to put the meeting in possession of what had taken place, they would find that, so far from having "caved in," they were as safe as they could possibly desire. (Applause.) The Chairman then put the resolution, when it was carried unanimously. The retiring directors, Messrs. F. A. Bevan and L. M. Rate, were next re-elected. The auditors, Messrs. Joshua Dean and Francis Glass, were also re-appointed. Cordial votes of thanks were then passed to the Chairman, Board of Directors and officers of the company, and the meeting separated.

THE INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.—The report of the directors of this Company, for the year ending December 31, 1879, presented at the sixteenth ordinary general meeting of shareholders, held as we go to press, states that the accounts show the result of the Company's operations for the past year—a result which the directors consider satisfactory. After deducting working expenses, depreciations, and bad debts, the net profit for the year is £52,354 5s. 8d. Adding to this £9,048 18s. 3d. brought forward from 1878 and £1,175 premium on new shares, and deducting £15,600 interim dividend paid in August and £2,100 written off shares in hand, there remains a disposable balance of £44,878 3s. 11d. Of this balance the directors have added £25,000 to the reserve fund, raising it to £50,000; and they recommend the distribution of £15,600 in dividend for the last half-year, being at the rate of ten per cent. per annum, free of income tax, carrying forward £4,278 3s. 11d. to the credit of the current year. The interest on the Company's debentures and loans is moderate, and is more than met by the interest received on debentures and shares held. The new 6 per cent. debentures issued last March were all readily taken. The year's sales compare favourably with those of 1878. The Company's steamships have been well employed, the *Dacia* principally in laying the new cable of 500 miles from Marseilles to Algiers, manufactured by the Company for the French Government, and completed in October. Several smaller cable contracts have also been carried out during the year. Mr. Silver and Mr. Bannatyne, who retire by rotation, offer themselves for re-election as directors.

THE CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED.—The report of the directors for the half-year ending 31st December, 1879, to be presented at the ordinary general meeting of shareholders to be held at the offices of the Company, on the 18th day of February, 1880, states that the gross receipts, including the balance brought from last account, amount to £19,972 15s. 10d., and the gross expenditure to £7,556 1s. 8d., leaving a sum of £12,416 14s. 2d. to the credit of revenue account. In the above amount of £7,556 1s. 8d. is included, however, the sum of £3,942 14s. 3d., the cost of the repair of the Cienfuegos-Santiago section of the original cable, and of the cutting out of the fault in and other repairs to the India-rubber (duplicate) cable, the ordinary expenses being £3,613 7s. 5d. The sum of £3,500 has been added to the reserve fund, increasing that fund to £27,086 10s. 7d. The balance of revenue, after providing for the dividend on the preference shares, will admit of a dividend on the ordinary shares at the rate of 6 per cent. per annum, leaving the sum of £1,116 14s. 2d. to be carried forward to the current half-year's account, and the Board recommend that dividends be declared accordingly, payable 19th instant.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (Limited) notify that, subject to the audit of the accounts, the directors propose paying a dividend of 15 per cent. (£1 16s.) per share, in addition to the ad-interim dividend of 5 per cent. already paid, making 20 per cent. for the year 1879.

The following are the final quotations of telegraphs for Feb. 12th:—Anglo-American, Limited, 62½-62¾; Ditto, Preferred, 88½-89½; Ditto, Deferred, 36½-36¾; Brazilian Submarine, Limited, 7⅞-8⅛; Cuba, Limited, 9-9½; Cuba, Limited, 10 per cent. Preference, 16½-17; Direct Spanish, Limited, 2-2½; Direct Spanish, 10 per cent. Preference, 11¼-11¾; Direct United States Cable, Limited, 1877, 11⅝-11⅞; Eastern, Limited, 9-9¼; Eastern 6 per cent. Preference, 11⅞-12⅛; Eastern, 6 per cent. Debentures, repayable Oct., 1883, 103-106; Eastern 5 per cent. Debentures, repayable Aug., 1878, 101-103; Eastern, 5 per cent., repayable Aug., 1899, 102-104; Eastern Extension, Australasian and China, Limited, 9-9¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 104-107; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 100-102; Ditto, registered, repayable 1900, 101-103; German Union Telegraph and Trust, 8½-9; Globe Telegraph and Trust, Limited, 5⅝-5⅞; Globe, 6 per cent. Preference, 11⅜-11⅝; Great Northern, 9⅛-9⅜; Indo-European, Limited, 24-26; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 10-11; Submarine, 235-245; Submarine Scrip, 2⅛-2⅜; West Coast of America, Limited, 2-2½; West India and Panama, Limited, 1⅞-2⅛; Ditto, 6 per cent. First Preference, 7¾-8¼; Ditto, ditto, Second Preference, 7-7½; Western and Brazilian, Limited, 7¾-8; Ditto, 6 per cent. Debentures "A," 98-101, Ditto, ditto, ditto, "B," 97-100; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 105-107; Telegraph Construction and Maintenance, Limited, 36-37; Ditto, 6 per cent. Bonds, 104-108; Ditto, Second Bonus Trust Certificates, 3-3¼; India Rubber Co., 14-14½; Ditto, 6 per cent. Debenture, 106-108.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 170.

CABLE PROPERTY.

THE past year has been a very advantageous one for the telegraph companies, at least, if we may judge by the considerable increase of the traffic receipts. In nearly every instance an addition to revenue has resulted on the year's business as compared with the previous year. The Anglo, Brazilian Submarine, Cuba Submarine, Direct Spanish, Direct United States, Eastern, Eastern Extension, the Great Northern, and The Submarine Companies all mark important increases. The returns of the West Coast of America and of the Western and Brazilian we have not at hand, whilst those of the West India and Panama Company show a slight decrease.

We do not think we shall be considered optimists when we assert that probably at no time in the comparatively recent history of submarine telegraphic enterprise has the future appeared more hopeful. Indeed, so rapidly does the business of the companies promise to extend that were it only possible to obtain greater permanency for the ocean threads, there would soon scarcely be found a better paying class of investment.

As, however, that lasting cable has not yet been proved to have been discovered, it is for the time necessary to pay particular attention to the accumulation of the respective reserve funds.

At what amount each should stand cannot well be told by any beyond the directorate or the scientific staff of any company, and not even by them, with any degree of accuracy.

This must depend on the nature of the ground over which the cable passes, the type of cable laid, the length of time it has been down, the amount of repair which has from time to time been effected on it, and also on so many considerations that it is impossible, as we before said, to estimate at what exact sums the reserve funds should stand; but, speaking generally, it will, we believe, be found that they are yet by far too meagre.

It has, therefore, been with considerable satisfaction that we have noted the constantly progressive increase of receipts, as it will enable the companies to obtain that position of security without which their properties seem destined to remain at their present low prices.

Another source of increasing value is to be found in the additions to existing systems, which should prove of pecuniary advantage to the parent stems, even though those additions may not be in themselves paying concerns. This would, of course, only be the case where the added but non-paying line was owned by a separate company. But where it is so, every extension of a system must render the pre-existing portion of that system of greater value than before.

On taking together the amounts of the receipts of twelve companies for 1879, and comparing them with those of 1878, we find the former exceed the latter by about £215,000, and this on a return of about £2,000,000. In the case of one of those companies whose returns we have not, namely, the Western and Brazilian, we hope that with Sir Edward Watkin's well known energy and talent it will now emerge from the cloud which has seemed to hang over it, and we trust that a similarly happy outcome may be found for the sorely tried West India and Panama Company.

Were it not for the competition which the American Cable Companies will have to meet, there seems every reason to think that the augmented receipts would not only be maintained but even still further increased—particularly as trade will, in all probability, more generally improve during the present year; but if sixpenny word tariffs are to prevail, immense loss must ensue to those companies engaged in the strife. It is to be hoped so suicidal a policy will not obtain, or, if it does, that it will be but of short duration.

In closing these few desultory remarks, we take this opportunity of congratulating the directorates and staffs generally, on the improved outlook, and of expressing the wish, that this time next year it will be our pleasing task to refer to submarine cable property as not only well paying, but also as well secured.

ON SOME OF THE EFFECTS PRODUCED BY AN INDUCTION COIL WITH A DE MERITENS MAGNETO-ELECTRIC MACHINE.

By WILLIAM SPOTTISWOODE, P.R.S.*

IN the *Philosophical Magazine* for November of last year I gave an account of a mode of exciting an induction coil by the direct application of one of M. de Méritens alternating machines, without the intervention of a contact-breaker or the use of a condenser. The experiments of Professor Dewar

* Proceedings of the Royal Society.

on the arc furnished by the machine itself, on its spectrum, and on its behaviour in respect of electrolysis, described before the Royal Society (*see* "Proceedings," Feb. 13, 1880), have led me to think that an account of some of the peculiarities in the induced discharge, to which the machine gives rise, might be acceptable to the Society.

And, first, as regards the secondary discharge in air. It was mentioned in the paper first quoted that the spark produced by this machine presented an unusually thick yellow flame, and that it was accompanied by a hissing noise different from that commonly heard with a coil excited by a battery. As the machine gives alternate currents, the secondary discharge presents sparks of equal strength in both directions, and the general appearance to the eye is symmetrical in respect of both terminals. The spark was observed in a revolving mirror, first in a vertical and secondly in a horizontal direction. The discharge, although apparently continuous, was immediately seen to be intermittent, with a period in unison with that of the machine. Tongues of flame, leading alternately from one terminal and from the other, crossed the field of view. The length of spark first used (vertically) was about half an inch. When the length was increased to about two inches flashes or bands of continuous light were seen to traverse the field of view in diagonals of low slope (*i.e.*, nearly horizontally), showing that there were masses of heated matter passing from time to time at moderate velocity between the terminals. From the known period of the machine, and the number of the discharges crossed by these flashes in their passage from terminal to terminal, it was calculated that the time of passage was about ·03 of a second. Occasionally there was a still brighter flash or meteor, which similarly traversed the field, but with a velocity apparently of about double that of the others.

When the discharge was set horizontally similar phenomena were seen; but at a distance about midway between the two terminals the flames appeared to meet, and at their point of meeting they showed continuous luminosity throughout. When the flame was blown aside there appeared occasionally, and at rather long intervals, the true spark, evinced by an irregular bright line, reaching from one terminal to the other.

On observing the discharge in air attentively it was noticed that whenever a true spark passed its passage was marked, as usual, by an irregular bright line when its path was outside the aureola or flame, but by a similar dark line when its path was within the aureola. Whether this be a merely subjective effect, due to the fatigue of the nerves of the retina by the bright spark, which always precedes the aureola in point of time, or whether it has any electrical significance, perhaps requires further examination.

The spectrum of the secondary spark was then examined with terminals of various metals.

Aluminium.—The spectrum showed a faint continuous background with the yellow sodium lines, and faint oxide of aluminium lines. This was with a spark of half an inch. But although the spark was subsequently lengthened, no difference in the spectrum was perceived, excepting that the continuous background was rendered more bright.

It would seem that these appearances are due to some such process as the following:—The heat due to oxidation, added to that of the discharge, is sufficient to volatilise the oxide of aluminium; but that in its passage across the interval between the terminals the oxide becomes so cooled that it gives a continuous spectrum. When the spark was lengthened, the oxide, although perhaps at first more heated than with the shorter spark, had more time to cool.

Magnesium.—In this, as in the former case, we have a faint continuous spectrum as a background, on which were seen the *b* group of magnesium lines. One other line in the blue occasionally flashed out, but was not permanently present. There was also a faint trace of the oxide spectrum. The contrast between the cases of aluminium and magnesium, in respect of the prominence of the oxide, or of the true metallic spectrum, is doubtless due to the fact that in the former case the oxide, and in the latter the metal, is the one which is more easily vaporised. On sending a blast of air on the discharge the blue line always disappeared, the current of air having lowered the temperature so far as to prevent the vaporisation necessary for its production.

When the spark between magnesium terminals was made to pass through hydrogen the characteristic lines of hydrogen were seen, apparently owing to a rise in temperature. This, as mentioned below, does not occur with carbon poles.

Platinum.—With terminals of this metal the spectrum was mainly continuous, with the addition of the ubiquitous yellow sodium lines. When the spark was short a few bands were faintly visible, some apparently those of nitrogen, and others in the blue and violet belonging to the oxide of platinum. When the spark was lengthened these bands disappeared, and nothing but the continuous spectrum (with the D lines) was visible.

It appears from these experiments that the application of the De Méritens machine to the induction coil furnishes us with the means of isolating certain lines of the metallic spectrum from the rest. It has, in fact, enabled us to reduce at pleasure the spectra of aluminium, of magnesium, and of platinum, to their most persistent lines; precisely as had already been noticed as occurring by natural processes in the cases of sodium and of calcium. As a general rule, when the spark is shortened the metallic, or the oxide, lines come out, when it is lengthened they disappear.

From this we may conclude (1) that the discharge which we have been examining is a real flame with metallic particles passing between the terminals in a solid condition; and (2) that in general the temperature is comparatively low, *i.e.*, that it is insufficient to cause any considerable vaporisation. This is notably the case when the arc is long, and when the matter thrown off from the terminals has sufficient time in its passage to cool.

The spark was then tried between carbon terminals in atmospheres of hydrogen and of carbonic acid. In none of them did the spectrum show any gas lines; but with hydrogen there were faint traces of the hydrocarbon group in the green. In this respect the spark differs from the discharge direct from the machine, inasmuch as the latter

gives some of the hydrogen lines in hydrogen and carbon lines in carbonic acid.

When the spark was discharged in a magnetic field known phenomena were reproduced, but owing to the thickness and mass of the flame and the extraordinary strength of the magnetic field they were exhibited in a state of great splendour.*

When the spark passed in an equatorial direction the whole flame was spread out in an equatorial plane, in which heated masses might be seen revolving in one direction or in the other in the neighbourhood of each of the magnetic poles. To give some idea of the actual appearance, it may be mentioned that a symmetrical spindle-shaped discharge, 15 millims. in length and 3 millims. in thickness, was spread out by the magnet into a disc of about 15 millims. in diameter and 1 millim. in thickness. When the spark passed in an axial direction, or when the poles themselves were made the terminals, the phenomena described in my paper "On an Experiment in Electro-Magnetic Rotation" ("Proc. Roy. Soc.," March 30th, 1876) were reproduced.

Whatever was the direction of the spark the resistance due to the magnetic field was such as to extinguish the discharge, provided that the striking distance was near the limit that it could attain when no magnetic field was present. If a plate of glass was interposed between the poles of the magnet (which were still used as terminals) the yellow flame disappeared, and the spark divided itself into numerous ramifications of true sparks which found their way round the edges of the plate. As soon as the magnet was excited the resistance in the field became so great as to exceed that of the glass plate itself, and the plate was pierced.

When magnesium terminals were used in an atmosphere of hydrogen, the yellow sodium lines, the blue and green magnesium lines, and the red line of hydrogen were visible near the terminals, with a continuous background. When the magnet was excited the only change observed was that the lines became slightly fainter.†

Professor Dewar was good enough to measure the efficiency of the secondary discharge, by taking an inch spark in a glass bulb placed in the centre of a calorimeter, in the same way as he had already measured the efficiency of the intermittent current direct from the machine. The former amounted to about 430 gramme-units per minute, while the latter had been found to be 6,000 per minute. The relative efficiency may, therefore, be taken at about 1 : 15. And as the machine was giving about 300 currents per second, this would give for the secondary

$$430 : 60 \times 300 = \cdot 023 \text{ units per discharge,}$$

and for the primary

$$6000 : 60 \times 300 = \cdot 3 \text{ units per discharge.}$$

The results in the case of the secondary discharge may not perhaps possess any great degree of accuracy; but, in the absence of any other information on the question, they may serve to indicate the general scale of magnitude by which the coil discharge is related to that of the machine.

Leaving the subject of the spark from the induction coil, one of the most remarkable effects produced by this machine was the illumination of vacuum tubes by the currents taken simply from the machine. A small sphere of about two inches in diameter, with an air-vacuum, and having two parallel straight terminals reaching nearly across the sphere and about half an inch apart, was (after the first attempt, when there was some difficulty in getting the discharge to pass) readily illuminated. Owing to the alternate currents, both terminals were of course surrounded with the usual blue halo. When the speed of the machine was reduced the discharge through the tube was not maintained, showing that only that part of the current from the machine which possessed the highest electromotive force, and perhaps also the greatest strength, was sufficient and was therefore actually used for the purpose. As this was apparently only a small fraction of the whole current, we may herein find an explanation of the fact that, compared with the effect from the induction spark, the illumination was moderate and the heating insignificant. It would perhaps not be easy to establish an accurate comparison between this and other sources of electricity; but some idea may be conveyed by the fact that, from experiments made with this tube with Mr. De La Rue's chloride of silver battery on a former occasion, and quite independently of the present question, it was estimated that a current having an electromotive force of 400 volts was necessary to produce a discharge.

Other tubes were tried, and were illuminated in the same way.

When the tube was placed in the magnetic field the discharge underwent the modifications described by Plücker, by Hittorf, and by others. But it may be mentioned as a result of the extraordinary strength of the field here employed that, whenever the tube was so placed that the direction of discharge made any considerable angle with the lines of magnetic force passing through it the discharge was completely extinguished. When the tube was removed to a weaker part of the field the discharge reappeared, distorted in form, and altered in colour in a manner known to those who have experimented in this direction.

* Through the kindness of the authorities of the Royal Institution, Faraday's great electro-magnet, excited by the Siemens machine, was placed at my disposal.

† There was some reason to think that, at the moment of making the magnet current, the lines became decidedly brighter, and that they lost their brilliancy if that current was maintained. But this, perhaps, requires further examination.

IT is a curious fact that in some lines of manufactures the Canadians are beating Yankees in economy of production. For example, the Waterous Manufacturing Company, of Brantford, Ontario, have, we learn, for some time past been delivering steam-engines in Bremen at less prices than the American makers can put them down there.—*Scientific American.*

MM. ANTOINE BREGUET, son of the celebrated member of the Institute, and RICHET have taken the joint direction of the *Revue Scientifique*, the largest and most influential French scientific periodical. M. Antoine Breguet will write more specially on physics, and M. Richet on chemistry. It is understood that M. Alglave, the former editor, has resigned in order to devote himself more entirely to the propagation of Spencerism and Monism.

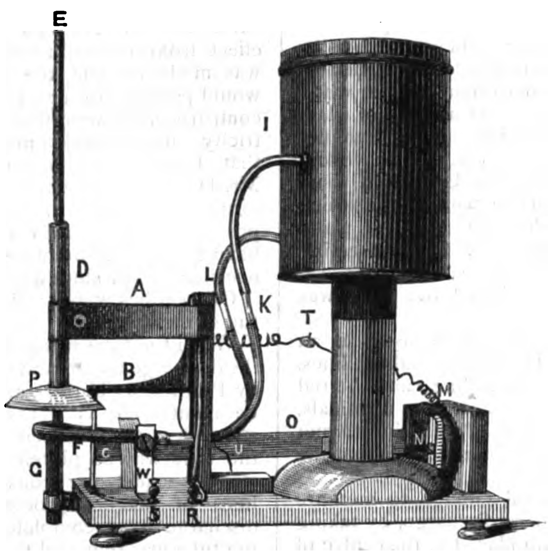
STEWART'S ELECTRIC LAMP.

THIS is a self-regulating lamp, capable of burning for a very long time without attention. It is simple in construction, inexpensive to manufacture, and, as the consumption of carbon is less than in most regulators, it may be said to be economical.

A general view of this lamp is shown by the figure. The action of the arrangement is as follows:—

The binding screws, R and S, being respectively in connection with the positive and negative poles of the dynamo machine, the current enters at R, passes along the support A, through the wire T and the electro-magnet M, then back through the wire U, the support B, and spindle C, to the binding screw S.

The armature N, being momentarily attracted by the magnet M, pulls on one side, by means of the lever O, the metal electrode F, which forms a ring round the carbon rod.



There is a flow of water through the electrode F, which latter works on a central spindle, C. The electrode F being now in contact with the carbon rod E, the current changes its direction in the following manner. It passes from R along the support A, through the metal tube D, to the carbon rod E. The carbon rod E may be of great length, so as to burn for a considerable time without renewal. The electric arc is formed between the inside edge of the ring electrode F and the carbon rod E, passing from E to F, and thence by the spindle C to the binding screw S. As soon as contact is established between the electrodes E and F, the armature N is released, and the electrode E is forced back to its normal position by means of the spring Q. The upright, W, is to prevent the electrode F going too far. G is a piece of insulated carbon to keep the carbon rod E from falling; its position can be regulated by means of a screw. I is a small cistern, from which water flows through the metal electrode F to keep the latter cool. K and L are flexible tubes, which convey the water to and from the cistern, the circulation being maintained by the different levels at which these tubes enter the cistern. P is a reflector to throw the electric rays downwards.

The electrode F is easily attached to the spindle C, and can be renewed if and when necessary. In practice, however, it has not been found to burn.

An advantage which this lamp possesses consists in the ease with which the carbons can be renewed when consumed, as they have merely to be dropped into the tube D. The carbons, indeed, need not be in long lengths, as pieces a few inches long may be piled one on the top of the other in the tube, and each piece will come into use as the one beneath it becomes consumed.

The arrangement of the different parts of the lamp, as shown by the figure, are not, perhaps, as compact as they might be, but this is simply due to the fact that the figure given is that of a trial lamp. The details could easily be modified without altering the general principle, which possesses points of novelty which seem highly advantageous.

It might be imagined that the water in the cistern would become heated quickly, and would require constant renewal. Such, however, is not found to be the case; a comparatively small volume of water is found to cool the electrode sufficiently to protect it from injury.

This lamp, which is not patented, is the invention of Mr. Charles Stewart, M.A., of 50, Colebrooke Row, London, N.

A lamp on a somewhat similar principle was patented recently by Messrs. Siemens. In this lamp the negative terminal consists of a vertical wire, preferably of iron, enclosed within a thin copper tube, which is surrounded by an outer tube or casing of larger diameter, so that between the two tubes there is an annular space through which water is made to flow. By connecting the upper and lower ends of the casing by flexible tubes with the upper and lower parts of a water cistern, the

heating of the water at the terminal causes a circulation which is sufficient for keeping the latter cool. The wire forming the core of the terminal is pressed upwards by a weight, float, or spring against a small shoulder or burr at the mouth of the inner tube, and as the wire wastes at its upper end it is continually fed upwards by the weight, float, or spring. The positive terminal consists of a carbon rod which is free to slide downwards within a water-cased tube, the lower end of the carbon resting against the end of a pin of platinum or other refractory metal screwed obliquely through an eye at the lower end of the casing. As the carbon wastes at its lower end it slides downwards, still bearing against the pin.

The system of cooling is to a certain extent disadvantageous, as it causes a diminution in the amount of light produced by a given current.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

IV.

THE MORSE DIRECT WRITER.

THE Morse Writer is more extensively used in the Postal Service than any other form of instrument. It is either worked "direct" or by "relay." In the direct working system the signals are recorded by the direct action of the line current, and inasmuch as the latter is liable to considerable variation and diminution on long wires, the system is only adapted for circuits under 100 miles in length.

The general arrangement of the apparatus is shown by fig. 17. In this fig. M is the electro-magnet, G a galvanometer, and *l* a lightning-protector; the outside case of the latter is connected to terminal E, by which it can be put to earth.

In some of the older forms of apparatus, which were not fitted with protectors, the terminal E was not provided, and terminals U and D were respectively lettered E and L.

Action of the Apparatus.

The working of the arrangement is as follows:—When the key, K, is depressed the Copper pole of the battery becomes connected with the front stop of the key, thence with the axle block of the same, through the galvanometer, G, and with the lightning-protector, *l*, with terminal D and the "Down" line. Terminals Z and U being permanently connected together, the Zinc pole of the battery is in communication with the "Up" line.

When signals are being received on the instrument, then the course of the current, supposing it to enter from the "Down" line, will be:—From terminal D, through the lightning-protector and the galvanometer, on to the hinge block of the key, thence by the back stop of the latter, through the electro-magnet, M, on to terminal U and the "Up" line.

The connections shown are those for an "Intermediate" station. If the instrument is at an "Up" station then terminal D must be connected to line and terminal U to earth. At a "Down" station U must be connected to line and D to earth.

Theoretically, and practically also, it makes no difference whether U or D be the Up or Down line terminals respectively, or whether Z or C be the Zinc or Copper terminals respectively; but as uniformity is very desirable, it is the rule to join up the instruments in the manner indicated.

The earliest forms of Morse instrument were of the "embosser" form, that is to say, the dots and dashes were formed by means of a style, which was forced into the paper and formed short or lengthened indents. Apart from the fact that no marking ink was required for this form of instrument, it had but little to recommend it, as it required considerable battery power to produce good marks; and the marks, such as they were, were by no means easy to decipher. Its continued use simply arose from the absence of an efficient method of producing the signals by ink marks.

The form of inker at present in use, and which is the best pattern yet introduced, was invented by Messrs. Siemens.

Fig. 18 shows a perspective view of a Direct Writer Morse of the most recent design. Fig. 19 is a side view of the same removed from its wooden base; and fig. 20 is a general top view, showing parts of the mechanism.

The under base of the instrument contains a drawer, A, in which is contained the paper slip; this drawer is shown by fig. 21. The roll of paper, P, rests on a circular brass disc, *f*, which runs easily on a pivot, *p*. The end of the slip is brought out under two wooden rollers, r_1, r_2, the axes of which are at right angles to one another. Of these rollers, r_1 is set at the end of a brass spring, so that if the paper is pulled out with a jerk, as happens sometimes, this spring yields, and prevents the jerk being communicated to the roll of paper and the disc on which it rests; the effect of such a jerk would be to cause the disc to spin round and unwind several turns of paper in the drawer, and thus cause a tangle. The paper, after passing under roller r_2, runs through a slit, *d* (fig. 18), in the wooden base, from thence it passes over a metal roller, *p* (fig. 19). This roller is provided with two adjustable collets, one on each side of the paper slip. The object of these is to enable the position of the slip relative to the inking disc to be adjusted, so that the marks on the slip may be made to come along the centre of the latter. After passing over this roller, the slip next passes under a small steel roller, whose pivot is seen at *o*; it then passes between the two rollers, *n*, *m*, and away from the instrument. Roller *m*, which is on a brass frame on an axle at *j*, is pressed against roller *n* by means of a spring, which gives sufficient grip between the former and the slip to enable the latter to be drawn forward by the action of the clockwork which turns the roller *n*. The surfaces of both the rollers are milled, to give the necessary friction.

A little handle is attached to the frame of the roller *m*, by which the latter can be lifted up to enable the paper slip to be placed in position when a fresh supply is brought into use.

The inking is effected by means of a disc, *i*; this disc is connected by an axle *g* (fig. 20), with the clockwork train; the further end of this axle is hol-

low and fits loosely over the end of the axle of a wheel, *w*, in train with the rest of the mechanism, the two being held together by a loosely fitting pin, *f*. The whole, in fact, forms a kind of universal joint, which enables the disc, *i*, to be kept rotated by the clockwork, and at the same time enables it to have a slight up and down motion when required.

The disc, *i*, dips into a small chamber which forms which is formed into a ring, *x* (fig. 20), through which the axle of the disc passes; the other end of the lever is secured to the brass piece, *k*, by means of two screws, *h'*; a third screw, *h*, is also provided by which a slight amount of regulation relative to the piece, *k*, and the armature, *a*, of which the former practically forms a part, can be given to the lever, *k'*.

The armature, *a*, is formed of a soft iron split tube,

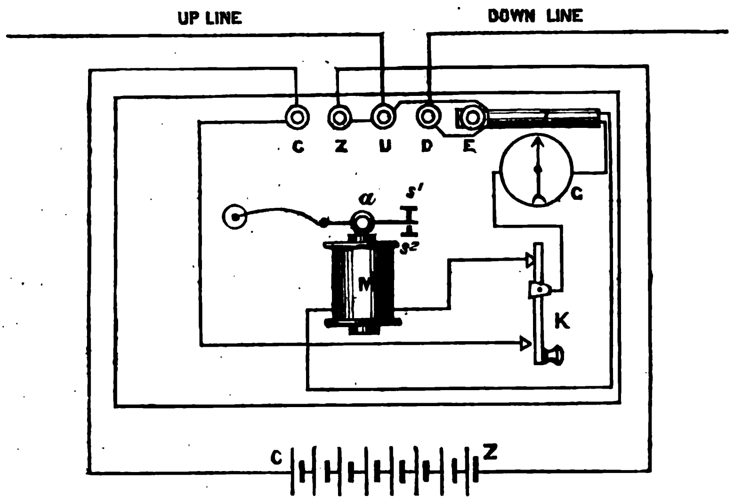


FIG. 17.

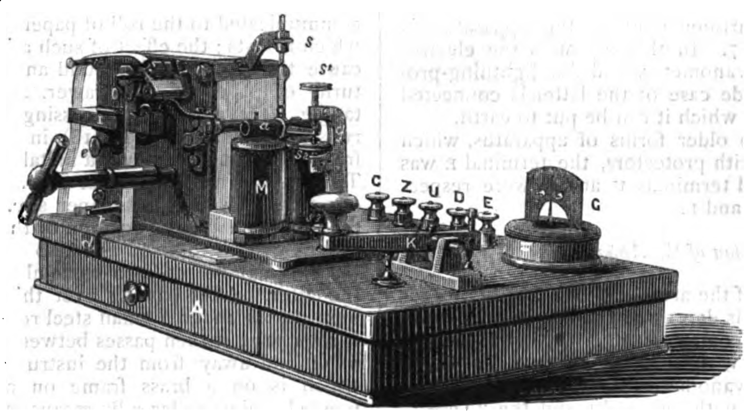


FIG. 18.

a part of, and is in communication with, the larger reservoir, I, which contains the marking ink. This reservoir is secured to the frame of the instrument by the thumb-screw, *e*, so that it can easily be removed when required. The rotation of the disc keeps the periphery well covered with ink.

The elevation of the disc against the paper slip is effected by means of the steel lever, *k'*, the one end of this shape being found to be more satisfactory than the ordinary flat form.

The axis on which the armature and its attachments are fixed is pivoted to brass cocks, K (figs. 19, 20). The "end shake" of the pivots is limited by steel plates, *v*, screwed against the cocks, K. It is much better to limit the "end shake" in this manner rather than to allow the shoulders of the pivots to bank against

the pivot brasses, as the free motion of the armature would be considerably impeded in the latter case, also it would be much more liable to stick.

The spring, z, which keeps the armature, a, in its normal position, is adjusted by the thumb-screw, s (fig. 18), attached to the bracket, b, fixed to the frame of the apparatus. The play of the armature is limited by the screws, s_1, s_2, secured to the bracket pillar, g.

The electro-magnet, M, is not fixed to the base of the instrument, but is attached to a broad plate, L (fig. 19), which is hinged at H. This plate is about fig. 19, are kept covered by an ebonite boxing, shown in fig. 18; the object of this is to protect the ends from injury, it having been found that the latter were very liable to be broken by dusting. The tongue, t, frees or stops the train of clockwork according as it is moved to the left or right.

Adjustment of the Instrument.

There are four distinct means of adjustment which can be given to the instrument in order that proper signals may be obtained.

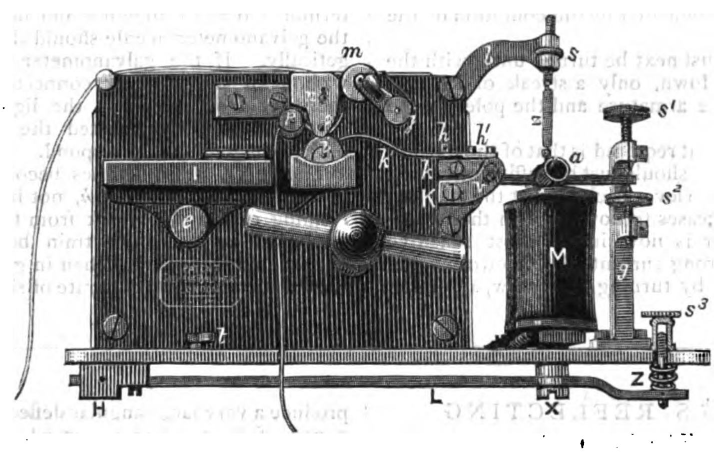


FIG. 19.

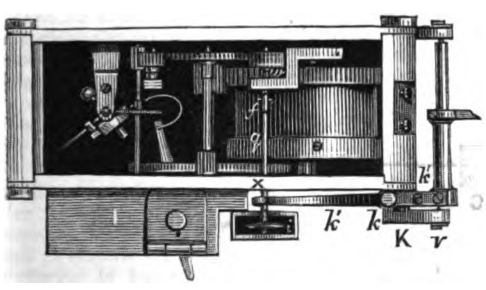


FIG. 20.

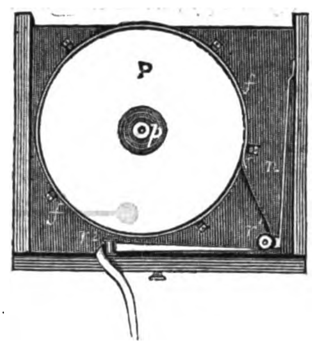


FIG. 21.

as wide as the magnet is broad, and is secured to the latter by means of two screws, one screwing into each core. The free end of this lever has a screw pivoted to it which screws into the thumb-screw, s_3; a spiral spring, Z, surrounding the screw and exerting its expansive force between the lever-plate, L, and the brass bed plate on which the clockwork is secured, tends to move L down, and thereby to lower the magnet, M; by turning the screw, s_1, it is evident that the lever, L, can be drawn up, and thus the magnet be raised.

The ends of the coil wires, which are seen in

1st. Screws, s_1 and s_2, which limit the up and down play of the armature, a.

2nd. The spring, z.

3rd. The screw, s_3, which regulates the proximity of the poles of the magnet to the armature, a.

4th. The screw, h, which regulates the position of the inking disc, i, relative to the paper slip and to the armature.

The latter means of adjustment is rarely required for general purposes, being practically only used when the instrument is adjusted after being taken to pieces for cleaning and repair in the workshop.

The regulation for ordinary working purposes is as follows:—

The screw, s_2, must first be adjusted until the disc, *i*, touches the paper lightly but firmly, that is to say, until the signals on the paper when the armature is gently depressed are clear and unbroken, whilst, at the same time, the armature lever fairly touches the screw, s_2. If the armature on being depressed does not produce a slight ring against s_2 the disc will be pressing too hard against the paper, and will produce thick marks.

The screw, s_1, may be next adjusted until the armature lever has about 1-16th of an inch play between the two screws.

This adjustment of the screws, s_1, s_2, applies to any circuit, and is not regulated by the condition of the line current.

The screw, s_3, must next be turned until, with the armature, *a*, held down, only a streak of light is visible between the armature and the poles of the electro-magnet.

The last adjustment required is that of the tension of the spring, *z*. This should just be sufficiently great to bring the armature lever back against the stop, s_1, when the current ceases to flow through the instrument. The latter is now in its most sensitive condition. For strong currents the electro-magnet should be lowered by turning the screw, s_3, and, if absolutely necessary, the spring, *z*, must be tightened up.

The magnet coils in the Direct Writer Instrument are wound to a total resistance of 300 ohms, and the apparatus should work well with a current of 3·3 milliwebers.

Faults.

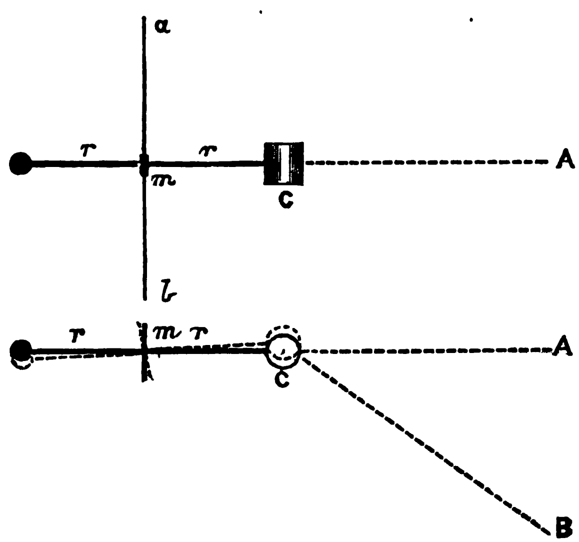
Apart from the adjustments, the faults to which the Direct Writer Instruments are liable are not numerous or troublesome to detect.

The battery being connected to Z and C, the instrument may be proved to be in good working order, as regards the out-going current, by connecting terminals D and U together and depressing the key, the galvanometer needle should then respond energetically. If the galvanometer needle responds without D and U being connected together, then there is a short circuit in the lightning protector. If C and D are connected the armature of the electro-magnet should respond.

The lever, *k′*, sometimes becomes loose on the piece, *k*, from the screw, *h*, not being tight. Slow running of the clockwork from the fly getting out of order, or from the train becoming clogged, occasionally happens. When in good order the slip should run through at the rate of six feet per minute.

RAPIEFF'S REFLECTING GALVANOMETER.

THE principle of magnifying the small deflection obtained on a galvanometer needle by means of a reflected ray of light, as in the Thomson galvanometer, has recently been still further developed by Mr. J. Rapieff. By this device an extremely small deviation of a magnetic needle may be made to produce a very large angular deflection of a reflected pencil of light. The way in which this is effected is shown by the figure. In this figure, *m* is the magnetic needle, suspended in the ordinary manner in the centre of a coil by means of a silk fibre, *a b*. At right angles to this needle is fixed a light bar, *r*, *r*, to one end of which is attached a counterpoise and to the other end a cylindrical mirror, C. A lamp at A throws a pencil of light on this mirror, as in



the Thomson galvanometer. So long as the position of the cylinder is such that the pencil of light is a normal to the surface of the mirror, then the reflected beam will be a normal also, that is to say, it will fall on the zero of the galvanometer scale. A very slight deviation of the cylinder, say, to the left, will cause the reflected beam to be deviated a very considerable angle in the direction B, as shown by the figure. It is evident that, by lengthening the rod, and making the cylinder, C, of a small radius, the sensitiveness of the arrangement can be indefinitely increased.

Notes.

THE Brush electric light system has been applied for illuminating purposes in the anthracite mines of Pennsylvania.

The same system is also in use at the mill of Mr. Louis J. Crossley, of Halifax, Yorkshire.

IT has been decided to permanently adopt the electric light in the reading-room of the British Museum. The system used, as perhaps our readers are well aware, is that of Messrs. Siemens.

"IRON" states that experiments are in progress at the North Shore Mills, Liverpool, under the direction of Mr. Ward, engineer of the British Electric Light Company, with the André incandescent lamp, which is said to possess several special advantages. The light is contained in a globe hermetically sealed, and, as the carbon rods are thus protected from contact with the air, they are not subject to combustion, or the combustion is so slow as to be almost imperceptible. The lamp is simple and effective. It is self-adjusting, devoid of mechanical appliances, and, as the carbon points are not consumed, it will remain illuminated for an indefinite length of time. The avoidance of any renewal of the carbon points is an obvious advantage, as is the fact that the new system admits of a complete subdivision of the current of electricity.

THE ELECTRIC LIGHT.—In the *Philosophical Magazine* for January, 1879, p. 30, Mr. W. H. Preece gives a discussion, in which he shows the condition to be supplied in electric lighting in order to obtain a maximum effect. In eq. 2, p. 31, he gives for the heat distributed to the incandescent material $H = \frac{E^2 l}{(p + r + l)^2}$ where p represents the battery resistance, and r and l represent the resistance of the connecting wires and incandescent lamp respectively. For n lamps joined up in series we must substitute $n\,l$ for l, while if joined in multiple arc we must put $\frac{l}{n}$ for l. In either case the value of H is found to be a maximum when the resistance of the lamp system is equal to the rest of the circuit. Mr. Preece then proceeds on the assumption that this condition cannot be complied with if n is large, reaching the conclusion that the amount of heat liberated in each lamp varies inversely as the square of the number of lamps. This is true in either of the two cases discussed by him. If, however, we have n lamps arranged in n' parallel circuits, in each of which we have n'' lamps, the previous equation becomes

$$H''' = \frac{E^2 \frac{n''}{n'} l}{\left(p + r + l \frac{n''}{n'} l\right)^2}$$

With this arrangement it is *always* possible to supply the condition which makes H''' a maximum, entirely irrespective of the value of n. If $p + r = \frac{n''}{n'} l$, we shall have $H''' = \frac{E^2}{4(p + r)}$; or, the total heat in n lamps is independent of the number of lamps. The heat generated in each lamp will then vary inversely as the number of lamps.—F. E. NIPHER, in *Van Nostrand's Engineering Magazine.*

THE Edison Electric Light Company, it is said, is not to have a patent for the carbonised paper horse-shoe lamp without a contest. The parties contesting Edison's claim for a patent on his new lamp are large capitalists, and are represented in Washington by attorneys whose speciality is electric light patent cases. It is evident that it will be a long time before this contest is settled; and if Edison does get a patent for his lamp, it will not be until after years of hard fighting.

THE following are the claims made before the Commissioners of Patents on behalf of the Sawyer-Mann lamp in the proceedings for an interference: 1. Incandescing arcs for electric lights made of carbon substantially, as hereinbefore set forth. 2. Incandescing arcs of carbon in combination with the circuit of an electric light. 3. The combination substantially, as hereinbefore set forth, of the circuit of an electric light, an incandescing arc of carbonised paper included in the circuit, and a close transparent chamber in which the arc is enclosed. 4. An incandescing arc made of carbonised fibrous or textile material.

M. PERUCHE has invented a new electric candle which consists of three carbons, two being cylindrical, 4mm. in diameter, and applied to each other, the third square, 5mm. thick, placed in the angle formed by the others. The holders are capable of oscillation, the square carbon being held by a spring in contact with the others while no circuit passes, but when the current begins, takes its separate position.

AT the next meeting of The Society of Telegraph Engineers there is to be a display of electric light apparatus; inventors and manufacturers are invited to exhibit.

DISTRIBUTION OF POWER BY ELECTRICITY.—Numerous experiments have lately been made in Paris on the transmission of power by means of two Gramme machines, one producing an electric current by mechanical action, the other operating inversely, and reconstituting a portion of the labour which was originally expended. In order to make careful measurements, M. Tresca estimated some of the experiments with a Gramme machine making 1,200 revolutions per minute. The current was transmitted by copper wires to carts at different distances, two Gramme machines being placed on the carts and acting on a windlass, which pushed a double Brabant plough so as to make a furrow 220 metres (240·6 yd.) long. The velocity of the plough, when the circuit of the current was 800 metres (874·91 yd.) was 88 centimetres (34·65 in.) per second, the shaft making

1,123 turns per minute; when the circuit was increased to 1,300 metres (1,421·72 yd.) the velocity was increased to 70 centimetres (27·56 in.) and the revolutions of the shaft to 890. The effective work was estimated at three horse-power.—*Comptes Rendus.*

AN experiment with the telephone between the Union Pacific Transfer on the east side of the Missouri River, opposite Omaha, Nebraska, and St. Louis, made on 25th January, over a distance of 410 miles, is reported to have been successful. An ordinary conversation is said to have been carried on with ease.

A NEW use has been found for the telephone. Captain Greer, of the Ordnance Department, U.S. Army, Springfield, Mass., employs it to determine the time of flight of small arm projectiles at long ranges. Two telephones, provided with Blake transmitters, were used. One was placed within a few feet of the gun and left open to receive and transmit the sound of the discharge. The other was in the shelter-proof, which was about thirty feet in front of the right edge of the target. A stop watch, beating fourths of a second, was used in connection with it. The telephone being at the ear, the instant the sound of the discharge was received at the target the watch was started, and, on the bullet striking, was stopped.

CURIOSITIES OF THE TELEPHONE.—With a single telephone held, say to the right ear, the transmitted voice appears to come from a distance to the right; while with a telephone held to the left ear, it seems to arrive from the left of the listener.

With a telephone to each ear, if one ear be less sensitive than the other, or if the telephone be held further from that ear, the voice apparently shifts to the side of the other ear; and if both ears hear alike and both instruments are equally near their respective ears, the voice apparently proceeds from in front of the observer.—*Scientific American.*

THE Montreal Telegraph Company, we learn, has actively promoted the supply and use of telephones, which they have already furnished to the extent of 690. By the report of this company, we find that the last year's receipts were 478,435 dollars, against expenditure 335,573 dollars, or a net profit of 142,862 dollars.

A PATENT has been granted in the United States to Mr. Emile Berliner for Electrical Contact Telephones, which invention, Mr. Berliner claims, is similar to the "Microphone," and which he used and described in the year 1877.

A BILL has been introduced in the State Assembly at Albany for the suppression of telegraph poles and the stringing of telephone wires across the tops of houses.

THE POSTAL TELEGRAPHS.—A deputation from the Associated Chambers of Commerce waited upon Lord John Manners, Postmaster-General, a few afternoons since, to impress on his lordship the necessity of adopting modifications of the present postal and telegraph system. Mr. Whitwell, M.P., and Mr. Jacob Behrens, Bradford, stated the views of the deputation as to the improvements that were required in the international and internal telegraphs and postal arrangements. Mr. Whitwell laid stress on the inconvenience which would be caused by the new regulations prohibiting the use of proper names except in their natural meaning, and Mr. Behrens suggested, amongst other things, cheap telegrams, at say 3d. or 6d., which he thought would ultimately add to the revenue of the Post Office. Lord John Manners pointed out that, so far as the members of the deputation had desired modifications of the regulations at present existing with regard to foreign countries, England had no power to alter the conclusion arrived at by a convention which was recently held, and no other convention could be made until all the contracting Powers assented to it. He need not impress upon them the difficulty of bringing such a convention together, considering that foreign countries, even as far away as Japan, were interested in it. He could only recommend them to ascertain how the present system worked, and bring the matter before the next Telegraph Conference that was held. As to the proposed alteration in the telegraph system of England, he could only say at present that he would give the matter his careful consideration. Respecting the Indian mails, he was not sure of the fact, but he thought that the regulations complained of were made by the Indian Postal Union, which was not in any way connected with this department.

MR. W. H. PREECE ON "WHEATSTONE'S TELEGRAPHIC ACHIEVEMENTS."—The evening lecture at the Royal Institution on Friday, February 13, was delivered by Mr. W. H. Preece, the subject being "Wheatstone's Telegraphic Achievements." The three principal telegraphic achievements of Wheatstone were the invention of the Needle, the A B C, and the Automatic instrument. The Needle instrument was patented in 1837, and the A B C in the year 1839. The latter form of instrument was greatly improved, and a new patent granted in 1858. Mr. Preece in his discourse pointed out the various stages of the development of the A B C instrument up to the existing perfect form of apparatus. The Automatic instrument was patented in 1858, but subsequently greatly improved. The apparatus as it now exists, Mr. Preece stated, was capable of, and had actually worked at the rate of 250 words a minute, this speed having been attained between Liverpool and London. By means of "translators" or "repeaters" a high rate of speed could be kept up on very long circuits with submarine cables in circuit.

In speaking of Wheatstone's character, Mr. Preece pointed out that Wheatstone could not be considered to be a great philosopher, but his chief merit lay in his eminent practical nature, that is, in his power of applying his inventions for practical purposes.

TELEGRAPHIC MONEY ORDERS.—We see no reason, says the *Investors' Guardian*, why the Government, having secured the telegraphs, should not make arrangements to use them for this purpose. For instance, it is quite possible, as is the case in Austria and other countries, for one man to send another £10 by telegraph for the same amount which it now costs him to remit that sum by means of a money-order. A post-office order entails the risk of delay.

THE Colonial Office has under consideration a scheme for a telegraphic cable to the Island of Bermuda, the Royal Commission on Colonial Defence having forcibly called attention to the isolated condition of that important station and naval depôt.

LAUNCH OF A NEW TELEGRAPH STEAMER.—On Saturday, the 24th January, there was launched from the yard of Messrs. James Laing, at Sunderland, a new steamer for the West India and Panama Telegraph Company (Limited), London. The *Grappler*, ss., measures 200 feet in length, by 29 feet beam, by 16 feet depth of hold, aud has been specially constructed for cable work. The vessel carries large tanks, has ample coiling space, and will receive her picking-up and pay-

ing-out gear in London. The *Grappler* is now at Messrs. R. and W. Hawthorn's receiving her engines. The work is being carried out from the plans and specifications of W. R. M'Kaig and J. Carlton Stitt, consulting engineers to the Company.

THE TELEGRAPH IN AFGHANISTAN.—Mr. C. E. Pitman and Mr. Lake, of the Indian Telegraph Department, have been nominated Companions of the Order of the Indian Empire, for distinguished services in connection with the erection of telegraph lines during the campaign in Afghanistan.

THERE is a rumour that yet another cable to America is projected.—*Herepath's Railway Journal.*

TELEGRAPHIC COMMUNICATION FOR THE WEST COAST FISHING.—Sir James Elphinstone, M.P., has obtained the sanction of the Treasury to have the telegraph carried on from Lochmaddy, in North Uist, to Loch Boisdale, in South Uist. There were considerable difficulties in the way, as the work involved the laying of several short cables. The importance of the fishery in that neighbourhood, however, has resulted in the Post Office being authorised to conclude an arrangement by which the desired extension will be enabled to be carried out. Information as to the early fishing at Barra has become urgently desirable, as it is attended by crews and curers or their agents from Peterhead, Fraserburgh, Buckie, and other ports on this coast.

THE CAPE CABLE.—The Eastern and South African Telegraph Company (Limited) announce the interruption of the Mozambique-Delagoa Bay section of their cable. The fault is reported to be near Mozambique, and the company's repairing vessel has left Aden to restore the communication.

THE American Union Telegraph Company's system has been opened in part. The eastern lines generally are now in operation, and western connections, through to Omaha, will soon be established.—*The Railway Times.*

AN International Meteorological Conference has been held in Sydney, at which it has been arranged to establish a uniform system of weather telegraphy for the different Australian colonies.

AT a meeting of the City Commission of Sewers it has been determined, as an experiment, to try the system of electric street alarm posts or boxes in cases of fire, and the points selected were in Upper Thames Street; Bridge Street, Blackfriars; St. Paul's Churchyard; at the General Post Office; in Gresham Street; Moorgate Street; at the Mansion House; and at the King William Statue, London Bridge.

NEW YORK CITY FIRE DEPARTMENT.—The statistics of the Fire Department show that the percentages of total destruction of buildings by fire were 7, 6½, and 5 per cent. in the years 1866, 1867, 1868 respectively, whereas the percentages in 1877, 1878, and 1879 were but 3·45, 1·14, and 1·6 respectively. This decrease is attributed to the perfected system of fire-alarms now in use.

ACCORDING to present arrangements the *Iris*, *Devastation*, and *Neptune*, are to be completed for sea at Portsmouth by the end of the financial year. It is intended to fit each of these ships with electric bells, the same as fitted to the Royal yachts.

TELEGRAPH WIRES IN NEW YORK.—A general scheme for underground wires in New York has been devised by Mr. R. D. Radcliffe. This scheme includes the re-arranging of the various systems of wires; the adoption of the idea will enable the number of poles which carry the wires at present to be reduced from about 10,000 to 1,600.

A SERIES of courses of lectures illustrating some of the applications of Physics to the Arts has commenced at South Kensington. Captain Abney will lecture on Radiant Energy and its relation to Photography, Prof. Adams on Electrical Measurement in relation to Telegraphy, Prof. Barff on Colour and Pigments in relation to Painting, and Dr. W. Stone on Sound in relation to Music and Musical Instruments. The fee is £1 for each course. The lectures commenced on February 23.

NEUTRALISATION OF SPARKS AT RELAY CONTACTS.—Mr. C. S. H. Small writing to the *Journal of the Telegraph* says:—"In making some experiments with condensers, with a view to reducing the amount of spark at the relay points in a stock quotation system, I made a discovery which may be of interest to your readers, and will, I think, be new to many of them. In our system the relay points are used to open and close circuits containing on an average 20 instruments of 5 ohms each, a line wire with a resistance of about 10 ohms, and about 70 cells of electropoin battery. The spark resulting from the closing and opening of these circuits is very destructive to the relay points, rendering necessary frequent fileing and re-adjustment, as well as causing considerable loss of time in the repetition, by the points being kept wide apart to break the spark.

"In trying to neutralise this spark with condensers of 9½ microfarads capacity, the condenser was connected with one of its sides to one point of the relay and the other side to the other point. The armature lever of the relay is connected with the main battery, and the lower contact with the line. It was found that after making a few vibrations, under these conditions, the relay points would become fused and stuck together tightly so that they had to be pried apart. The discovery referred to above is in the method of connecting the condenser. In the second series of experiments the condenser was connected with one side to the earth direct and the other side to the line wire after it leaves the lower contact point of the relay. The result was that a condenser of 8½ microfarads answers perfectly well, completely removing the spark and allowing of good working with the relay points as close together as on ordinary Morse lines. After a trial of one month no faults have been developed to counterbalance the advantages gained."

IT has been noted that during the present weather crisis the Montsouris electrometers have shown not a single negative reading. This positive state has continued for the last three months. The readings are taken eight times a day.

THE measurement of the resistance of liquids is known to be a matter of some difficulty, as the current causes the electrodes placed in the liquids to polarise and add their resistance to the liquid under measurement. Thus erroneous results may be attained. Herr Niemöller gets over this difficulty by employing a telephone instead of a galvanometer on the Wheatstone bridge used for making the measurements, and sending a rapid series of reversed currents through the apparatus instead of a continuous current; it is found that in the position where the galvanometer shows no deflection the tone in the telephone has a well-marked minimum of intensity. Supposing the liquid resistance

has 2,000 units, a variation from it, of only four units, reveals itself in a displacement of the minimum position.

An improved form of needle for Thomson's Quadrant Electrometer has been devised by Herr Edelmann; the needle, instead of being a flat plate, consists of two quadrants cut vertically from a cylinder. This swings concentrically within another cylinder slit into four quadrants, which replace the usual pairs of flat quadrantal plates. The needle and its attached mirror are supported by a bifilar suspension, and the charge is given to the needle by connecting the cup of concentrated sulphuric acid, into which it dips, with the pole of a Zamboni pile.

Thomson's Galvanometer.—When electric currents are measured with the aid of Thomson's reflecting galvanometer, the indications read on its graduated scale are found not to be proportional to the values of the currents measured, and to be exaggerated in proportion as those values increase. This cause of error arises from the fact that the angles of deflection of the magnetised needle are doubled by the reflection of the mirror, and consequently it is not the tangents of the real angles of deflection that one reads on the scale, but the tangents of the doubled angles. If it can be assumed without inconvenience that the tangent of the double of a very small angle is twice that of the simple angle, the case is not the same for large angles; and although the deflections of the needles of this class of apparatus are limited, with the aid either of a directing magnet or of derivations, to about 8°, the indications are already sensibly exaggerated at the extremities of the scale which the 8° include. I essayed to remedy this defect. by substituting a very fine platinum wire ($\frac{1}{1000}$ in diameter) for the untwisted thread of silk by which the system of needles of the galvanometer are suspended; but the want of proportionality was produced in the opposite sense, and was more considerable. I then had recourse to a bifilar suspension composed of two cocoon-threads very close to one another. The results were almost completely satisfactory. By this second means the errors are not entirely corrected; but they are reduced to less than one-hundredth of the value measured. The verification experiments were made, using the whole extent of the graduated scale, with the aid of three condensers charged from one and the same constant source of electricity. The condensers were first charged and measured separately, and afterwards charged and measured in combination."—A. Gaiffe in *Comptes Rendus*.

Luminous Tubes.—M. Trève, in *Comptes Rendus*, recounts the following experiment:—"Into a large Geissler tube I introduced a Fizeau's condenser. The two poles of the induced current of the Ruhmkorff end at the condenser through the intermediations of the ordinary electrodes of this kind of tubes, which, fused into the glass, are fixed to the eleventh and twelfth sheets of tinfoil. When the induced current passes into the condenser, the tube still containing air at the atmospheric pressure, the usual humming is heard. If vacuum be gradually produced in the tube the humming grows more and more feeble. At last, if air be withdrawn until only a pressure of three or four millims. is left in the tube, the ear can no longer perceive anything; but a brilliant white light appears, springing in the form of beads from the tinfoil of the condenser, and absolutely distinct from the pale and indistinct phosphorescent light of Geissler tubes."

Having in view the energetic effects of the secondary battery of Planté, M. D'Arsonval has proposed the construction of a much more powerful condenser. There are two causes which limit the power of Planté's battery—the gaseous state of the reduced metal, that is to say, of the hydrogen, and the cessation of the oxidation of the lead so that the surface of the lead plate is entirely covered with a layer of oxide. This latter effect is much diminished by greatly increasing the area of the metallic plate, whilst the other effect the author gets rid of by substituting for the hydrogen a soluble metal, that is to say, by replacing the water by a salt of zinc. To increase the lead surface he uses very fine lead shot. His secondary couple then consists of a plate of zinc, and one of carbon surrounded by fine shot, in a concentrated solution of sulphate of zinc. A voltaic current is sent through from the carbon to the zinc, effecting deposition of zinc on the zinc, and formation of peroxide of lead on the lead, the sulphuric acid remaining free. With a small couple, containing 1 kg. of fine shot, a Desprez motor was worked four hours. Still better results are got if a layer of mercury be substituted for the zinc plate; the electrolysed zinc forms an amalgam with it, and the couple retains its charge a long time. Its maximum electromotive force was found equal to 2·1 volts.

Electricity of the Blowpipe Flame.—Referring to a supposed discovery by Col. Ross of the magnetic property of the blowpipe flame, Mr. Herbert M'Leod writes to *Nature* on the subject:—"Col. Ross's experiment seemed of such importance that I thought it advisable to repeat it, and it may be of interest to some of your readers to hear of the result and of the way in which my experiment was conducted.

"A compass in a closed box, to prevent the influence of air currents, was placed close to a brass Herapath blowpipe, and after the position of the needle was noted the gas was lighted and air was blown through the flame; no deflection of the needle was observed. As the compass is an old one and there was probably some friction on the pivot, it was replaced by a piece of magnetised watch-spring attached to a mirror, and suspended in a glass case by a single silk fibre; this apparatus being placed on a stone slab, light from a lamp was reflected from the mirror on to a screen. The arrangement was so delicate that the needle was set in oscillation by the movement of the iron rod connecting the blowpipe with the treadle; so, to avoid any possible disturbing cause, the air was supplied by water pressure from a copper gas holder. When the jet was brought near the needle, the flame being either in the magnetic meridian or at right angles to it, not the least movement of the spot of light was perceived, although the screen was at a distance of about eight feet from the mirror.

"As this result is so much at variance with that of Col. Ross, it would be interesting to know exactly how his experiment was performed."

Herr E. Wiedemann has recently made further experiments on the phosphorescent or fluorescent light produced by electric discharges (*Wied. Ann.*, No. 1). Nearly all platino-cyanide double salts show fluorescence under the discharge; but, so long as they were undecomposed, no double fluorescence was observed. When platino-barium cyanide had been traversed by a single discharge, the strong green fluorescent light showed no dichroism, but, after a series of discharges, dichroism appeared. It also occurred when the crystals of that or other platino-cyanide double salts were left a long time *in vacuo* (without electric discharge) whereby they lost water; and the more rapid appearance of dichroism under the electric discharges is attributed to heating of the crystals. Herr Wiedemann opposes Mr. Crookes's view, offering the following proof of its incorrectness:—If the positive current of a Holtz machine be sent through a very thick-

walled discharge-tube, and the discharges be made to follow one another in such a rhythm that they are deflected from their course in the tube by the finger, only a weak phosphorescent light appears on the inner side of the tube, but a very bright green light appears on the *outer* side. The non-observation of this before is probably due to the thinness of the tubes commonly used. In narrow, and especially capillary tubes, too, only the inner wall becomes luminous.

M. TRÈVE finds that the dynamic magnet formed by a solenoid of iron wire has its magnetic polarity four times more intense for the same force of current than a solenoid constructed in identically the same manner with a wire of copper or other diamagnetic metal.

HARDENING STEEL.—The engravers and watch-makers of Germany are said to harden their tools in sealing wax. The tool is heated to whiteness and plunged into the wax, withdrawn after an instant and plunged in again, this being repeated until the steel is too cold to enter the wax. The steel is said to become almost as hard as the diamond.

A COMPANY has been incorporated under the title of the "Navigating Telegraphs Company (Limited)." Capital £20,000, in 4,000 shares of £5 each, payable as follows: £1 per share on application and £1 10s. on allotment. The directors are: Sir Philip Haughton Clarke, Bart., W. Cope Devereux, Esq., R.N., F.R.G.S., Colonel W. Wallingford Knollys, F.R.G.S., H. W. Maynard, Esq., A. R. Robinson, Esq., C.E., Nassau J. Senior, Esq. The intention of the Company is to work patents for Steering and Engine Room Telegraphs. It will interest our readers in the trade to hear that the patents are those of Mr. Francis, whose name is too well known for comment to be necessary.

A COMPANY to work Mr. Henley's business, under the title of W. T. Henley & Co. (Limited), was registered on Saturday the 21st inst. The capital has been subscribed by a few friends.

PATENT MAGNETIC WATER METER COMPANY.—A new company has been registered under this title with a capital of £10,000 in £5 shares. It is intended to purchase of Mr. Daniel Backhouse Syers, of 106, Fenchurch Street, the patent rights entitled, "Improvements in apparatus for measuring water or other liquids, applicable also as a current meter and motor;" also to acquire the right to use the said invention in Belgium and Germany.

AN extraordinary prize of 3,000 francs has been awarded by the French Académie des Sciences to Mr. Crookes, F.R.S., in recognition of his recent discoveries in molecular physics and radiant matter.

THE Chinese Government, through the efforts of His Excellency Li Hung Chang, have at length decided to establish a complete system of telephones throughout China; at least, for the present, in that part of China north of the Yang Tse Kiang. Mr. J. A. Betts is now on his way home to make arrangements for carrying out the work. It will be remembered that the Chinese Government have already a telegraph line fron Tientsin to Taku, the stores for the construction of which were sent from this country, and which line was erected by Mr. Betts, with the students of the Imperial Torpedo College, Tientsin—the first successful telegraph line in China—and which may be considered to be the forerunner of the more important work about to be put in hand.

Review.

The Telegram Code, 3rd Edition. By DR. AGER, 50, Wellington Road, Stoke Newington.

IT has been remarked that a second edition of any work tests an author's ability. Granting the truth of this, we feel inclined to add that we regard a *third* edition as a greater evidence of his successful accomplishment of the task he has set himself, especially when we find the work constantly increasing in extent and popularity, as is the case with the "Telegram Code."

The first edition, published in 1875, was out of print in a short time, and many of our readers might have seen advertisements frequently appear offering two or three hundred per cent. above the published price for copies of the work.

The book is so well known that it is not necessary for us to enter into any very minute description of its merits.

Some few characteristics only of the present edition require to be noted.

As in the first edition, a large part of the work is provided with alternate pages containing code words only. Other parts of the book, referring to contracts, markets, offers, orders, shipments, &c., are provided with five columns of code words, in addition to that on the opposite page. It is intended that the sentences attached to the latter shall also apply to the former for any articles in which telegraphers may be specially interested. By this simple device, several thousand sentences may be made to apply to any five articles requiring frequent telegrams, the sixth being left for occasional telegrams.

Very large additions have also been made to the tables of *price* and *quantity* in order to meet the wants of merchants, whose facilities for telegraphing fractional prices, advances or reductions in market quotations, have been largely curtailed by the late Convention. Thus we find every fraction from $\frac{1}{64}$ upwards to a unit of a penny, followed by a further rise of $\frac{1}{32}$ to 1s., and again to other grades upwards to £150,000,000, with blank code words affording facilities for a still further increase. Another feature of the present issue is the addition of Rupee Currency, which, we doubt not, will be welcomed by the large body of merchants trading with India.

To us who are outside the mercantile world, the "Telegram Code" affords many subjects of interest, as the author has contrived to concentrate in his work a large amount of the experience of City and other merchants.

Of the code words it is unnecessary to say anything further than that they are strictly within the lines of the late Conference, and appear to have been most carefully selected.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—I see that the practicability of telegraphing by currents from Gramme and other dynamo-electric machines is still being discussed in the electrical journals. It might, therefore, interest your

readers to know that this company's instruments have been worked in Paris for about two years past by a Gramme machine and gas-engine with perfect success, and more economically than if batteries were used.

Yours truly,

F. HIGGINS.

Exchange Telegraph Company,
17, Cornhill.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—With reference to the concluding paragraph of your notice of my patent magnetic cut-off for dynamo-electric machines in your issue of 15th inst., I may tell you that previously to perfecting my patent I experimented with the method you mention, and found it resulted in a signal failure.

In the first place, the electric current will, in obedience to its natural laws in reaching a given point, take the shortest circuit; consequently, if I connect my cut-off with the dynamo, the current from the latter will be so powerful as not only to overcome the cut-off, but will entirely fuse the connections.

Again, if I put a resistance to control the current from the dynamo to the cut-off, when I make use of the rheostat coil to lessen the current from the dynamo to the plating bath I so weaken the current applied to the cut-off that it refuses to act unless the spring of the cut-off is regulated at the same time, according to the current required in the bath. Of course, this could be done, but electro-platers, as a rule, not being skilled electricians, a mistake would sooner or later be made. Apart from this, the waste of time occupied in so regulating the spring of the cut-off would raise an objection from every practical man.

I am, dear Sir, yours faithfully,

GMO. ZANNI.

47, Holborn Viaduct,
23rd February, 1880.

Proceedings of Societies.

PHYSICAL SOCIETY.—ANNUAL GENERAL MEETING, February 14.

Professor W. G. ADAMS, President, in the chair.

THE PRESIDENT read the report for the past year, which showed that the position and prospects of the Society are in every way satisfactory, and that more papers were communicated during last year than in any previous year. The following list of council and officers was elected for the ensuing year, and votes of thanks were given to the President, the Lords of the Committee of Council on Education, and to the Treasurer, Demonstrator, and Secretaries, President Sir W. Thomson, LL.D., F.R.S., Vice-President (who has filled the office of President) Professor W. G. Adams, M.A., F.R.S., Vice-Presidents, Professor R. B. Clyton, Dr. Huggins, Lord Rayleigh, Dr. Spottiswoode; Secretaries, Professor Reinold, and W. Chandler-Roberts, F.R.S.; Treasurer, Dr. Atkinson; Demonstrator, Professor Guthrie; and Members of Council, Capt. Abney, Walter Bailey, M.A., J. H. Cotterill, F.R.S., Dr. Warren de la Rue, Major Festing, R.E., Professor G. C. Foster, Professor Fuller, Dr. J. Hopkinson, Dr. Schuster, G. Johnstone Stoney, F.R.S.; Honorary Member, J. E. R. Clausius.

After this business the meeting resolved itself into an ordinary one, and the following new members were elected: Senor Roig y Torres, of Barcelona, Mr. Mollison, Mr. Hare, Mr. J. C. Lenis, Miss Caroline Martineau.

A paper "On a Quartz and Iceland Spar Spectroscope Corrected for Chromatic Aberration" was then read by Dr. W. H. STONE. The spectroscope consists of two Iceland spar prisms and a quartz train. It differs in no respect from those ordinarily made, except in the fact that the object glasses of the telescope and collimator are doublets, with a positive lens of quartz and a negative of Iceland spar. The latter has a dispersive power so far greater than that of quartz that an approximation to achromatism may be easily obtained. In a spectrum there is less fear of indistinctness from superposition of images than in a telescope; but a greater amount of focusing is required with unachromatic lenses, insomuch that lines in the field at one time need alteration to obtain distinctness. Moreover, it is an obvious advantage to transmit the whole of the rays coming from the collimator as nearly as possible parallel through the intra-objective space and the prisms. The object glasses were made by Mr. Ahrens about four years ago, and sent to Professor Macleod. They were put aside, but have been recently re-mounted owing to M. Cornu having recently published a similar device.

A paper "On an Automatic Switch for Telephone Circuits" was then read by Dr. WYNNE. The object of the switch was to enable any client of a telephone exchange to communicate with any other through the central office without the need of an assistant at the office. Mr. VARLEY and Professor AYRTON criticised the device, and the latter thought that the contacts might not be always reliable.

Professors AYRTON and PERRY then read a note on their "Theory of Terrestrial Magnetism." Professor Rowland of Baltimore had pointed out an error in their calculation which vitiated their results, and they, therefore, admitted that the charge of statical electricity on the surface of the earth assumed by them as competent to account for the earth's magnetism, was not sufficient to account for the whole, but only a portion of that magnetism. Nevertheless, they thought that the changes in the distribution of such a charge due to changes in the condition of the dielectric medium between the earth and the sun might account for the observed perturbations in the magnetic elements.

THE SOCIETY OF TELEGRAPH ENGINEERS.

THE ordinary general meeting of this Society was held on Wednesday, February 25th, Mr. W. H. PREECE, President, in the chair. The minutes of the last general meeting having been read and confirmed, the PRESIDENT rose and stated that he wished to correct a statement made by him in his inaugural address, viz., that microphonic telephone transmitters had superseded those of other forms in certain of the telephonic systems now in operation. He wished to say that this was not the case with Edison's system, the transmitter employed by that gentleman being very slightly different from that originally employed by him. The President's statement in his address should, therefore, not apply to Edison's system.

A discussion on Mr. EDEN's paper, on "Morse Signalling by Magneto-Electric Currents," was then

invited, but no remarks having been made on the subject, a discussion was invited on Mr. WILSON's paper, on "Compensating Induction in Telegraph Wires."

Mr. J. T. HILL stated that the amount of condenser capacity required for balancing duplex circuits varied with the state of the weather, a greater amount being required in fine than in damp weather. A number of circuits and the condenser power required for each in various weathers were enumerated.

Mr. WILLOUGHBY SMITH gave a description of some experiments made on a portion of the French Atlantic Cable when the latter was lying in the tanks on board the cable ship. One thousand miles of this cable was coiled in one tank, then a considerable quantity in two other tanks, and the remainder of the length, viz., 200 miles, was coiled on the top of the 1,000 miles. The induced effect produced by the two lengths of cable on one another in the one tank produced a distinct kick in the signals transmitted through the whole cable.

PROFESSOR AYRTON gave some formulæ representing the effect of the different kinds of induction.

Mr. A. J. S. ADAMS pointed out that electro-magnetic induction was sudden in its effects, and electrostatic induction prolonged, arguing from this fact that Professor Ayrton's formulæ were possibly incorrect.

Mr. C. A. MORGAN pointed out that the condenser capacity required for working a No. 8 was the same as for a No. 4 wire. He also pointed out that in the recent form of Wheatstone's receiver with short electro-magnets compensating resistances were not required.

PROFESSOR HUGHES stated that since 1868 a commission had been sitting in France, the object of which had been to endeavour to get rid of the effects of induction between wire and wire; but little progress had been made by the commission as yet.

The PRESIDENT argued that the capacity of a line varied with the amount of moisture in the atmosphere, this being shown by the fact that the working speed was less in wet than in fine weather.

A paper by Mr. J. B. STEARNS, on "A Fault in the Construction of Differential Galvanometers," was then read by the Secretary.

In this paper it was shown that in winding mirror differential galvanometers the parallel winding of the wire from two bobbins produced an unequal arrangement of the two wires, so that although the sum of all the effects of the turns of one wire was equal to the sum of the effects from the other turns, these effects were unequally distributed, and, consequently, the difference of the effect on the magnetic needle was only *nil* when the needle was in a particular position within the coil, by slightly shifting the needle the balance was thrown out.

In the discussion which followed the reading of the paper, Messrs. KEYSER, FOSTER, and STROH took part.

The meeting then adjourned.

At the next meeting an exhibition of electric-light apparatus will be held.

New Patents—1880.

458. "An improved method of and apparatus for extracting or recovering metals from their ores." W. R. LAKE. (Communicated by A. E. Tichenor.) Dated Feb 2. Complete.

553. "Improved regulators or lamps for the electric light." G. W. WIGNER. Dated Feb. 9.

573. "Improvements in apparatus for closing or emptying water pipes or other fluid conduits, parts of which improvements are applicable generally for shunting electric circuits." H. J. HADDAN. (Communicated by F. Fried.) Dated Feb. 10.

578. "Improvements in electric lamps, and in the method of manufacturing the same." T. A EDISON. Dated Feb. 10.

583. "Improvements in the means and apparatus for conveying persons or objects from one locality to another by electric motive power." C. H. SIEMENS. (Communicated by E. W. Siemens.) Dated Feb. 10.

602. "Improvements in the utilisation of electricity for light, heat, and power, being an improved system and means for the generation, regulation, distribution, measurement, and translation of electricity into light, heat, or power." T. A. EDISON. Dated Feb. 11.

624. "Improvements in or applicable to machinery, or apparatus for the manufacture of engine packing, insulated telegraph wires, and other similar manufactures." G. F. JAMES. Dated Feb. 12.

630. "Lighting by electricity." Hon. R. T. D. BROUGHAM. Dated Feb. 13.

631. "Improvements in and applicable to telephones, and to phonographic apparatus connected therewith." F. H. F. ENGEL. (Communicated by W. Klinkerfues.) Dated Feb. 13.

636. "Producing the electric light." A. M. CLARK. (Communicated by C. L. Pilleux.) Dated Feb. 13.

638. "Electric telegraph apparatus." W. R. LAKE. (Communicated by B. Thompson and C. Selden.) Dated Feb. 13. Complete.

671. "An electric telegraph for railway trains." G. DALSTRÖM. Dated Feb. 16.

695. "Improvements in and relating to cables of conductors for telephonic and telegraphic purposes." W. R. LAKE. (Communicated by C. E. Chinnock and J. De H. Harrison.) Dated Feb. 17.

699. "Improved apparatus for preventing the injurious effect of induced or escaping electrical currents in telephonic or telegraphic lines." W. R. LAKE. (Communicated by C. E. Chinnock and J. De H. Harrison.) Dated Feb. 17.

725. "Improved means and apparatus for distributing currents for electric lamps or candles." J. IMRAY. (Communicated by La Société Générale d'Electricité.) Dated Feb. 18.

751. "Improvements in and relating to telegraph wires, and the method or process of manufacturing the same." F. J. CHEESEBOROUGH. (Communicated by A. K. Eaton.) Dated Feb. 20.

752. "Improvements in and relating to magnets and telephones and combinations of magnets with telephones." F. J. CHEESEBOROUGH. (Communicated by A. K. Eaton.) Feb. 20.

756. "Electrical conducting wires." A. W. REDDIE. (Communicated by H. Menier.) Dated Feb. 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

2016. "Compound for insulating." FREDERICK SANDERS and LUDWIG DANCKWERTH. Dated May 21. 2d. Has reference to an insulating compound, called

"electra compound," to be used either alone or in combination with india-rubber and gutta-percha, or similar resins. It contains vegetable-tar oil, coal-tar oil, linseed oil, ozokerit, spermaceti, and sulphur.

2110. "Producing light and heat by electricity." C. W. Siemens. Dated May 27. 10d. This has reference to previous patent of Oct. 22, 1878, wherein is described the cooling of the terminal of an electric lamp by means of a stream of water passed through a cavity formed in the terminal. The arrangement as now patented consists of a vertical wire, preferably of iron for the negative terminal, enclosed within a thin copper tube, which is surrounded by an outer tube or casing of larger diameter, so that between the two tubes there is an annular space through which water is made to flow. By connecting the upper and lower ends of the casing by tubes with the upper and lower parts of a water-cistern the heating of the water at the terminal causes a circulation which is sufficient for keeping the terminal cool.

2267. "Illuminating by electricity." George Grout and Richard Sennett. Dated June 9. 2d. This invention is intended to increase the illuminating power of the electric arc by passing through or around the electrode gases or vapours rich in carbon or other substances in a fine state of division, by which means they become incandescent, and so increase the light.

2321. "Production and regulation of electricity for illumination." J. Devonport Finney Andrews. Dated June 11. 6d. Consists of a dynamo machine, the parts of which are largely exposed to the air; of a commutator for varying electric power, and for varying and distributing electric power. It also relates to an electric lamp, the most notable feature of which is presenting the voltaic arc at the edges of parallel discs or concentric tubes, causing the arc to move round these edges by induction from several adjacent convolutions of the conducting wire of the lamp.

2339. "Obtaining light by electricity." A. M. Clark. (A communication from the firm of A. de Méritens & Co.) Dated June 12. 6d. Relates to a multiple carbon "burner" for the production of the electric light. With this "burner" the arc is not formed between two but between a number of electrodes, by deriving the principal current through as many branches as there are conductors. This derivation is effected under such conditions that the tension of each derivation is proportional to the resistance of the arc interposed in it. Or instead of derivations of the principal current, secondary currents may be used produced by the inductive action of the primary current. These induced currents may be merely those generated in the intermediate carbons which the current passes, the burner in that case working without any other device than that necessary to send the current through the two outside carbons.

2402. "Electric lights and apparatus for developing electric currents." Thomas Alva Edison. Dated June 17. 10d. Consists of the incandescent lamp and electric generator already described.

2481. "Transmission of power by electricity." John Hopkinson. Dated June 21. 6d. Relates to effecting the reversal of the direction of motion of the armature or revolving portion of the dynamo-electric or magneto-electric machines when used as motors, by changing the position of the points of contact of the brushes, or equivalent devices, and commutator or collector.

2493. "Fire alarm." L. Alexandre Brasseur and Octave Antoine Ernest Dejaer. Dated June 21. 6d. Claims a tube contact maker charged with wax, paraffin, or other solid, fusible just below the point at which induction is desired to be given.

2543. "Manufacture of carbon candles or points for electric lighting." Felix John de Hamel. Dated June 25. 4d. Relates to the manufacture of candles or points, or plates of carbon combined with wire or metal.

2554. "Producing motive power for the rotation of magneto machines." J. Banting Rogers. Dated June 25. 6d. The object of this invention is the production of motive power for the rotation of magneto machines used for lighting purposes by mechanism governed and controlled by a falling body or column of water.

2600. "Receiving apparatus for telephonic communication." Frederick Aldridge Ormiston. (A communication from abroad by H. McIntire.) Dated June 27. 2d. Relates to a form of friction telephone. (*Provisional only.*)

2629. "Submarine telegraph cable." Auguste Blondot and Jules Bourdin. June 30. 4d. The cable is composed of a single copper conductor, covered with several insulating coatings. The first of these, in contact with the conductor, being of gutta-percha, the second of caoutchouc, the third of gutta-percha, the fourth of caoutchouc, the fifth of gutta-percha, mineralised by a mercurial salt. The cable is further surrounded by a covering of tarred hemp.

2744. "Electric lamps." George Whyte. July 5th. 6d. Has reference to improvements in the construction of electric lamps or lights, especially with revolving disc electrodes or carbons, and of the moving parts or mechanism for revolving these, and producing the electric arc and light between them, with or without an optical centre, being improvements upon and simplication of an invention previously patented, the number of said patent being 5152, 1878.

2769. "Electric lighting." H. E. Newton. Dated July 7th. 2d. (A communication from H. Whiteside Cook, of Niederdorf Tyrol.) Relates to an apparatus, consisting of a drum, so arranged as to send a current to several lamps in succession, and revolving at such a speed that the intervals between the flashes of light shall be so short as to produce the optical illusion of the said light being continuous. (*Provisional only.*)

2905. "Galvanic battery." Charlotta Helena Carlson. Dated July 16. 2d. Consists of an arrangement of zinc and copper plates, or other suitable elements, placed parallel to each other in a compact and suitable form, with a specially retained exciting salt or basic acid between them of such a character that when combined with a slightly acid or saline solution (such as the perspiration of the body) a slight and gentle electrical current is produced, the body completing the circuit between the positive and negative poles.

3778. "Manufacture of telegraph cables." W. R. Lake. (A communication from Joseph McTighe and Philip Arbogast.) Dated September 19. 6d. Relates to the enclosing of wires or cables with glass, or other vitreous covering, to protect them from the atmosphere, or to insulate them for electrical use. It also relates to a coupling for connecting sections of the said wires or cables, these being especially suitable for underground telegraphs.

3843. "Electrical signalling apparatus." A Melville Clark. (A communication from W. Hadden, of New York.) Dated September 24. 6d. Relates to a signalling device consisting of a non-conducting trough, having two wires connected with two corresponding series of exposed contact points in the bottom of the trough in combination with a separate metallic

circuit closer, having a bifurcated end; to a rheostat, formed of a non-conducting tube filled with carbon powder to adapt it to be applied to the circuit wire of a battery; and to the combination of a local circuit and a rheostat with the line circuit of a district telegraph signalling apparatus.

City Notes.

Old Broad Street, Feb. 26th, 1880.

THE INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.—The sixteenth ordinary general meeting of the above Company was held on February 12th, at the Cannon Street Hotel, Mr. GEORGE HENDERSON in the chair. A resolution for the adoption of the report (*see* abstract in THE TELEGRAPHIC JOURNAL of February 15th) was proposed by the CHAIRMAN, who said the Company's works were in an excellent condition. One drawback, however, was the advance in the price of raw material, while they found a difficulty in persuading purchasers to pay more than formerly. The resolution was seconded by Mr. SILVER, when Dr. H. SMALL moved an amendment that the report be not adopted, and called attention to the fact that the directors were continually issuing debentures, and asked whether that issue was to be limited. The Board were also frequently writing off sums for depreciation, but the value of their property was not apparently increased. The directors' remuneration he also considered exorbitant, as they were receiving £5,000 between them per annum. The amendment was seconded by Dr. HANCOCK, who agreed with the previous speaker, and compared the action of their directors with those of the Telegraph Maintenance Company, who had voluntarily reduced their own remuneration at a period of depression, and he, therefore, called upon the Board to follow that example. The CHAIRMAN, in reply, stated that the issue of debentures was limited, and further, that with regard to the directors' remuneration, that was fixed by the shareholders, who had it in their power to make any alteration they thought fit. The amendment was then formally put to the meeting, and rejected with but two dissentients, and the original resolution declared carried.

CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED.—The seventeenth ordinary general meeting of this Company was held on February 18th, at the offices, Old Broad Street, Mr. T. HUGHES, Q.C., presiding. The CHAIRMAN, in moving the adoption of the report (an abstract of which appeared in our last issue), referred with satisfaction to the gratifying increase in their business. They had again carefully considered whether they could declare an increased dividend on the ordinary shares, and had come to the conclusion that, for the present, it would be more judicious not to do so. They thought they would not be in a thoroughly safe position till they had a reserve fund of £50,000. The Company was in the most satisfactory position, and their prospects were very encouraging. The motion was seconded and adopted unanimously, and the dividend recommended was declared, after an amendment, that a bonus of 1 per cent. in addition should be paid, had been lost. The meeting then separated.

THE SUBMARINE TELEGRAPH COMPANY.—The half-yearly meeting of the proprietors was held at the City Terminus Hotel, Cannon Street, on the 17th inst., Sir J. CARMICHAEL, Bart., in the chair. The SECRETARY read the notice convening the meeting, the report being taken as read. It stated that, in comparing the accounts for the six months ending 31st December, 1879, with those for the corresponding period of 1878, it will be seen that there has been an increase in the receipts, while a small decrease has occurred in the cost of repairs to cables. The net result of the business for the six months just passed shows a sum of £35,084 6s. 8d. belonging to the Chartered Company, which enables the directors to recommend a dividend at the rate of 18½ per cent. per annum, and to add £2,550 1s. 3d. to the reserve fund. The proprietors are probably aware that a cable between France and America has recently been laid down, and opened for traffic by the Paris and New York Telegraph Company. The directors have agreed upon terms with the managers of that Company for placing a cable across the Channel, to land at Penzance, so as to establish another telegraphic route between England and America; and the Paris and New York Company are negotiating with Her Majesty's Postmaster-General for the use of a land line, from London to the coast, to be placed in connection with the cable. The general introduction of a word rate for European correspondence will be made on the 1st April next, which, no doubt, will cause some increase in the expenses of the Company; but, on the other hand, the directors anticipate a considerable augmentation in the number of messages, as they believe that the public will readily avail themselves of the great advantages afforded by the new tariffs. The CHAIRMAN said it really gave him sincere pleasure on that occasion of meeting them that he had not to preface the few remarks he had to make with the usual statement as to depression of trade and commerce, which he believed that the chairmen of companies had had to do for some years past. He believed that the turn in the tide had come, and that they might expect better times. There was one subject he had to say a few words on. In the last three months they had ceased to publish the monthly statement of their traffic, which they had usually done. There had been a slight disagreement between themselves and the Post Office as to a charge of certain rates on the Continent. Until that was settled they thought it might only be illusory to them to publish the statement, and they, therefore, stopped the publication. He need hardly remark that their relations with the Post Office had always been of a most friendly nature, and the present was only a little question of account, which he had no doubt would be settled in an amicable manner. He drew attention to that because, when he put the motion for their approval, it would stand as follows:—"That the report and accounts now read, with the addition of the words 'exclusive of a sum in suspense claimed from the Post Office,' following the words 'to amount received during the half-year,' in the statement of joint earnings, be received and adopted." Their traffic was most satisfactory, and they had every reason to look forward to the current half-year being quite as good as last. He then put the resolution as above. It having been seconded, the CHAIRMAN, in reply to a shareholder, said that the expense of the new cable would be entirely borne by the Paris and New York Telegraph Company. It would be laid from a point near Brest to a point near Penzance. The cable was the property of the Submarine Telegraph Company, but the other company would lay the cable under the supervision of this Company, whose engineer would be on board the ship. The cable would be laid by arrangement with the Submarine Company, by which they would receive from the other company a considerable sum. He should think that the distance would be about ninety miles. He then put the resolution, and it was carried unanimously. Con-

tinuing, he moved "That, in accordance with the recommendation of the directors, a dividend for the half-year ending 31st December, 1879, at the rate of 18¾ per cent. per annum, less income-tax, on the capital of the Company, be declared, and become payable on and after the 1st of March next." The motion, having been seconded, was carried unanimously. A vote of thanks was passed to the chairman and directors. The CHAIRMAN, in acknowledging the compliment, expressed a hope that next half-year they would be able to lay before the shareholders an equally satisfactory report. The proceedings then terminated.

THE DIRECT UNITED STATES CABLE COMPANY, LIMITED.—The report of the directors for the six months ending 31st December, 1879, states that the revenue for the half-year, after deducting out-payments, amounted to £120,445 8s. 6d., against £89,943 14s. 8d. (after similar deductions) for the corresponding half-year of 1878, being a difference of £30,501 13s. 10d. in favour of the half-year under review. The working and other expenses, including interest on debentures, amounted to £25,001 3s. 6d., leaving a balance of £95,444 5s. as the net profit of the half-year; making, with £2,345 1s. 5d. brought forward from the previous half-year, a total balance of £97,789 6s. 5d. For the corresponding half-year of 1878 the working expenses and other payments amounted to £21,748 9s. 11d. Interim dividends of 1¼ per cent. each for the quarters ending 30th September and 31st December, 1879, together amounting to £30,355, have been declared and paid. The directors have, after mature deliberation, considered it expedient in the permanent interests of the Company to add a further substantial amount to the reserve fund, and have accordingly placed to the account of that fund a sum of £48,942 2s. 9d., thereby increasing it to £150,000. The sums of £1,900 on preliminary, liquidation, and arbitration account, and £914 7s. 1d., the cost of removing spare cable, together amounting to £2,814 7s. 1d., have been written off, and £15,677 16s. 7d., the balance of the £97,789 6s. 5d. mentioned above, is carried forward. The cables are now, and have been during the half-year, in good working order without any interruption. The £100,000 debenture loan has been placed, and the proceeds have been applied in completing the measures necessary on taking up the 3,813 shares of the dissentients, and paying off the £17,300 seven per cent. debentures of the old Company. The residue puts the capital account of the Company on a thoroughly satisfactory footing.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.—The report states that, after charging interest on the debentures, the accounts for the year exhibit a net profit of £98,988, making a total of £158,341, with the sum brought down. An interim dividend of 5 per cent. has already been paid, and it is now proposed to pay 15 per cent., making a total dividend for the year of £2 8s. per share, or 20 per cent. The sum left to be carried forward is £68,701. During the 12 months the Company manufactured 6,917 miles of cable, including the duplicate line, 2,441 miles in length, between Penang and Port Darwin, and the line, 3,845 miles, from Aden to Natal.

The following are the final quotations of telegraphs:—Anglo-American, Limited, 60-60½; Ditto, Preferred, 88½-89½; Ditto, Deferred, 32¼-32¾; Brazilian Submarine, Limited, 7¾-8¼; Cuba, Limited, 9-9½; Cuba, Limited, 10 per cent. Preference, 16½-17; Direct Spanish, Limited, 2-2½; Direct Spanish, 10 per cent. Preference, 11¼-11¾; Direct United States Cable, Limited, 1877, 11¼-11½; Eastern, Limited, 8⅞-9⅛; Eastern 6 per cent. Preference, 12-12½; Eastern, 6 per cent. Debentures, repayable October, 1883, 103-106; Eastern 5 per cent. Debentures, repayable August, 1878, 101-103; Eastern, 5 per cent., repayable Aug., 1899, 101-103; Eastern Extension, Australasian and China, Limited, 8⅞-9⅛; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 100-102; Ditto, registered, repayable 1900, 101-103; German Union Telegraph and Trust, 8½-9; Globe Telegraph and Trust, Limited, 5½-5¾; Globe, 6 per cent. Preference, 11¼-11½; Great Northern, 9⅜-9⅝; Indo-European, Limited, 24-26; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 11-12; Submarine, 235-245; Submarine Scrip, 2⅛-2⅜; West Coast of America, Limited, 2⅛-2⅜; West India and Panama, Limited, 1⅞-2⅛; Ditto, 6 per cent. First Preference, 7¾-8¼; Ditto, ditto, Second Preference, 7-7½; Western and Brazilian, Limited, 7⅜-7⅞; Ditto, 6 per cent. Debentures "A," 98-101, Ditto, ditto, ditto, "B," 97-100; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 105-107; Telegraph Construction and Maintenance, Limited, 35½-36½; Ditto, 6 per cent. Bonds, 104-108; Ditto, Second Bonus Trust Certificates, 2⅞-3⅛; India Rubber Co., 13-13½; Ditto, 6 per cent. Debenture, 106-108.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,370	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
January, 1880 ...	*	a 15,869	3,200	... ...	*	48,887	28,009	17,280	... ...	*	... ...	13,534	5,307
January, 1879 ...	50,400	13,778	3,000	951	16,800	39,226	24,695	13,856	... ...	9,064	2,125	*	5,492
Increase	... ...	2,091	200	... ...	... ...	9,661	3,314	3,424	... ...	... ...	... ...	... ...	... ...
Decrease	... ...	... ..	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	185

* Publication of receipts temporarily suspended. a Five weeks.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 171.

PATENTS.

WE recollect reading, some years ago, in one of the works of the celebrated American humourist Artemus Ward, a description by the facetious author of a trial of some newly-invented artillery. The great point of novelty in one of these wonderful inventions consisted in the fact that the carriage of the piece was painted of a bright red, instead of the usual regulation colour. In looking at the plentiful crop of patents that are published weekly, we cannot but be reminded of the above anecdote, though we would not go so far as to say that the improvements for which patents are taken out are often as slight or as ridiculous as in the case in point. At the same time, however, the improvements, which are considered as such, and which are made the subjects of a patent, are often so slight that the sum expended in protecting the same can hardly be regarded as other than thrown away. Since the telephonic and electric-light rage set in, the coffers of the patent authorities have received a considerable accession of coin from this source alone, and a careful examination of the whole list of patents taken out on the two subjects certainly does not give one an impression that common sense has in all cases been the guiding spirit. It would be invidious to mention any special cases, but that such exist there can be no doubt.

By speculation is usually understood an investment in shares on the chance of a rise in their value, but we are inclined to think that the term is equally applicable to patents. A patent is practically an investment, and, in many cases, it is purely a speculative one, the liability being, however, limited, and the amount invested small, but still the amount, although small, is often more than the inventor can afford, and might be saved if care was taken not to rush to the patent agent unless the ideas devised are something more than different ways of effecting an already accomplished object, which a very large number of inventions are in reality. To a certain extent, the expense of a patent acts as a check upon indiscriminate protection, and, for this reason, a change in their cost may not be desirable. A change in the laws governing the administration of the Patent Office is, however, much to be wished for, and will no doubt be effected at some future date, for the present, however, the question has been unavoidably shelved.

ON THE DYNAMO-ELECTRIC CURRENT AND ON CERTAIN MEANS TO IMPROVE ITS STEADINESS.

By C. WILLIAM SIEMENS, D.C.L., F.R.S.*

THE author, after alluding to the early conception by Dr. Werner Siemens of the dynamo-electric or accumulative principle of generating currents, makes reference to the two papers on the subject presented, the one by Sir Charles Wheatstone and the other by himself, to the Royal Society in February, 1867. The machine then designed by him, and shown in operation on that occasion, is again brought forward with a view of indicating the progress that has since taken place in the construction of dynamo-electrical machines, particularly those by Gramme and Siemens von Alteneck. The paper next points out certain drawbacks to the use of these machines, both of them being subject to the disadvantage that an increase of external resistance causes a falling off of the current; and that, on the other hand, the short circuiting of the outer resistance, through contact between the carbon electrodes of an electric lamp, very much increases the electric excitement of the machine, and the power necessary to maintain its motion, giving rise to rapid heating and destructive sparks in the machine itself.

An observation in Sir Charles Wheatstone's paper is referred to, pointing to the fact that a powerful current is set up in the shunt circuit of a dynamo-electric-machine, which circumstance has since been taken advantage of to some extent by Mr. Ladd and Mr. Brush, in constructing current generators.

The principal object of the paper is to establish the conditions under which dynamo-electric machines, worked on the shunt principle, can be made to give maximum results. A series of tables and diagrams are given, the results of experiments conducted by Mr. Lanckert, electrician, employed at the author's works, which lead up to the conclusion that, in constructing such machines on the shunt principle, the resistance on the rotating helix has to be considerably reduced by increasing the thickness of the wire employed, and the resistance on the magnets has to be increased more than tenfold, not by the employment of thin wire, but by augmenting the length and weight of coil wire employed.

The results of this mode of distributing the resistances is summarised as follows:—

1. That the electro-motive force, instead of diminishing with increased resistance, increases at first rapidly, and then more slowly towards an asymptote.

2. That the current in the outer circuit is actually greater for a unit and a half resistance than for one unit.

3. With an external resistance of one unit, which is about equivalent to an electric arc, when thirty or

* Proceedings of the Royal Society.

forty webers are passing through it, 2·44 horse-power is expended, of which 1·29 horse-power is usefully employed, proving an efficiency of 53 per cent., as compared with 45 per cent. in the case of the ordinary dynamo machine.

4. That the maximum energy which can be demanded from the engine is 2·6 horse-power, so that but a small margin of power is needed to suffice for the greatest possible requirement.

5. That the maximum energy which can be injuriously transferred into heat in the machine itself is 1·3 horse-power, so that there is no fear here of destroying the insulation of the helix by excessive heating.

6. That the maximum current is approximately that which would be habitually used, and which the commutator and collecting brushes are quite capable of transmitting.

Hence the author concludes that the new machine will give a steadier light than the old one with greater average economy of power, that it will be less liable to derangement, and may be driven without variation of speed by a smaller engine; also that the new machine is free from all objection when used for the purpose of electro deposition.

This construction of the machine enables the author to effect an important simplification of the regulator to work electric lamps, enabling him to dispense with all wheel and clockwork in the arrangement. The two carbons, being pushed onward by gravity or spring power, are checked laterally by a pointed metallic abutment situated at such a distance from the arc itself that the heat is only just sufficient to cause the gradual wasting away of the carbon in contact with atmospheric air. The carbon holders are connected to the iron core of a solenoid coil, of a resistance equal to about fifty times that of the arc, the ends of which coil are connected to the two electrodes respectively. The weight of the core (which may be varied), determines the force of current that has to pass through the regulating coil in order to keep the weight in suspension, and this in its turn is dependent upon the resistance of the arc. The result is that the length of the arc is regulated automatically, so as to maintain a uniform resistance signifying a uniform development of light.

WARBURTON AND CROSSLEY'S RELAY.

THIS invention forms the subject of a joint patent by Mr. E. C. Warburton, telegraph engineer and superintendent to the Lancashire and Yorkshire Railway Company, of Manchester, and Mr. Louis John Crossley, of Dean Clough, Halifax, the inventor of the Telephonic Transmitter, described and illustrated in our issue of the 1st May, 1879. The object of the invention is the sensitisation and simplification of polarised relays generally, whether used for single or double current working. These improved relays may be used with advantage in the place of the ordinary soft iron relays, since, unlike the latter, they are devoid of adjusting springs. The invention is particularly applicable to the double relay employed with the Bright's Bell In-

FIG. 1

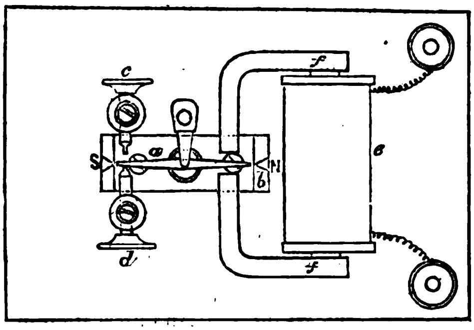


FIG. 2.

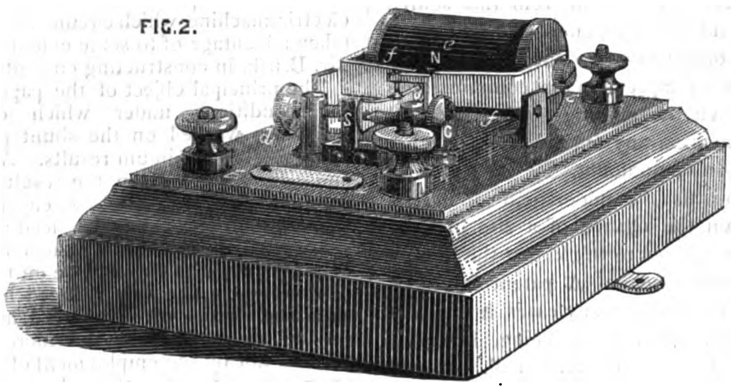


FIG. 3

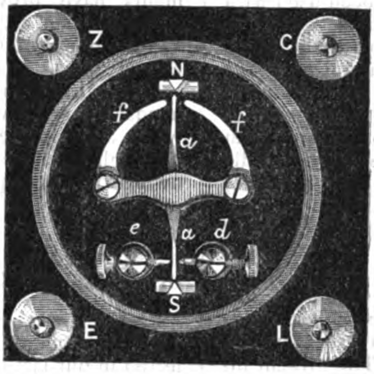
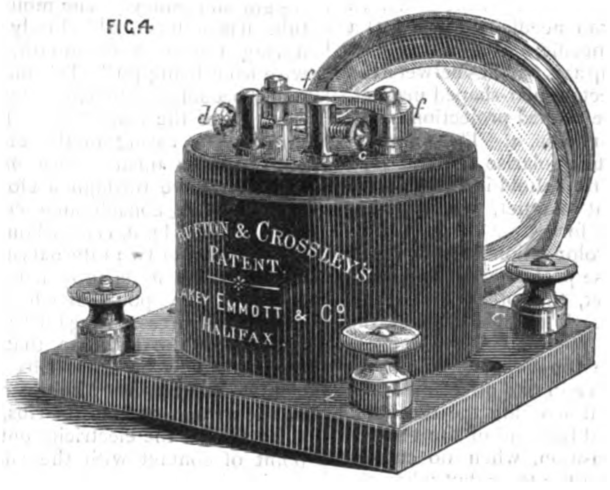


FIG. 4



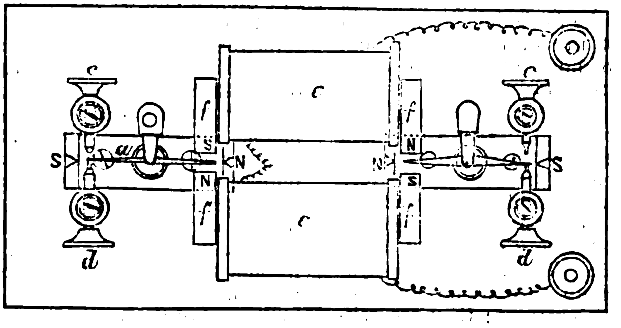


FIG. 5.

strument,* as it renders this form of relay very easy of adjustment, and, moreover, it does away with its liability to become demagnetised.

The Bright's Bell Instrument has been used with much success in the Lancashire and Yorkshire Railway Company's telegraph department since 1870 on their important circuits, and it has been frequently shown that this form of instrument, with a given quantity of wires and clerks, enables a greater amount of work to be got through than would be possible by means of the single needle (visual) instruments or single sounder (audible) instruments. It is well known that the Bright's Bell Instrument has a working capacity of forty and forty-five words per minute in ordinary message work, the receiving clerk writing for himself, and it has, therefore, appeared desirable to Mr. Warburton to remove the recognised defects of so desirable an instrument, and to increase its usefulness even in less skilled hands. The present invention is the successful result of experimental efforts to the foregoing end.

Figs. 1, 2, and 3 will make clear the nature of the invention. Fig. 1 shows a plan of one form of the relay, and fig. 2 a perspective view of the same. In these figs. *a* is a soft iron needle and *b* (fig. 1) a permanent magnet. The needle, *a*, is mounted at its centre upon a point and cup axis and lies between the poles of the permanent rectangular-shaped magnet, *b* (fig. 1), which has wedge-shaped projections, N, S, opposite the ends of the needle, *a*. These projections being highly magnetic, polarise the soft iron needle, and, at the same time, hold it in a position parallel to the permanent magnet, when undisturbed by other magnetic forces. *e* is an electro-magnet and *f*, *f*, are prolongations of its poles. Between the ends of these prolongations one end of the tongue, *a*, is set, the other end plays between two stops, *c*, *d*. It is evident that the magnetisation of the pole pieces, *f f*, will cause a to and fro motion of the tongue, *a*, according as the current passes through *e* in one direction or the other. For double current working the screws, *c*, *d*, may be so adjusted that the end of the tongue, *a*, may, in its normal position, when no current passes, lie midway between the two; but when the relay is required for single current working, then the screw, *d*, must be screwed up till the tongue just banks against it in its normal position. Fig. 3 shows a plan and fig. 4 a perspective view of a relay on the same principle as the foregoing, but in which the electro-magnet is of the ordinary form, and fixed vertically instead of horizontally as in fig. 2. Fig. 5 shows the invention adapted to a Bright's Bell Relay. Where many of the old form of the latter are used, such as on the Lancashire and Yorkshire Railway telegraph system, it is found that a converted instrument removes completely the irregularities of working and need of adjustment so common to the old form, and a greater despatch of business and saving of cost of maintenance results therefrom. The improved instruments are self-adjusting up to extreme limits of variation in the working currents; they are self-magnetising after being once charged in the workshop; and they are undemagnetisable by lightning. As regards sensitiveness, the relay will respond properly to a current of ½ a milliweber, and also will respond properly to a current of 20 milliwebers or more without readjustment. Experiments have proved that the tongue responds promptly and accurately to the currents from a Wheatstone automatic transmitter going at a high rate of speed.

It has also been proved that in the same clerk's hands the relay will work on a defective circuit where a single needle instrument with the old form of Bright's Bell relay had become quite inoperative owing to reduced potential of current from weather influences.

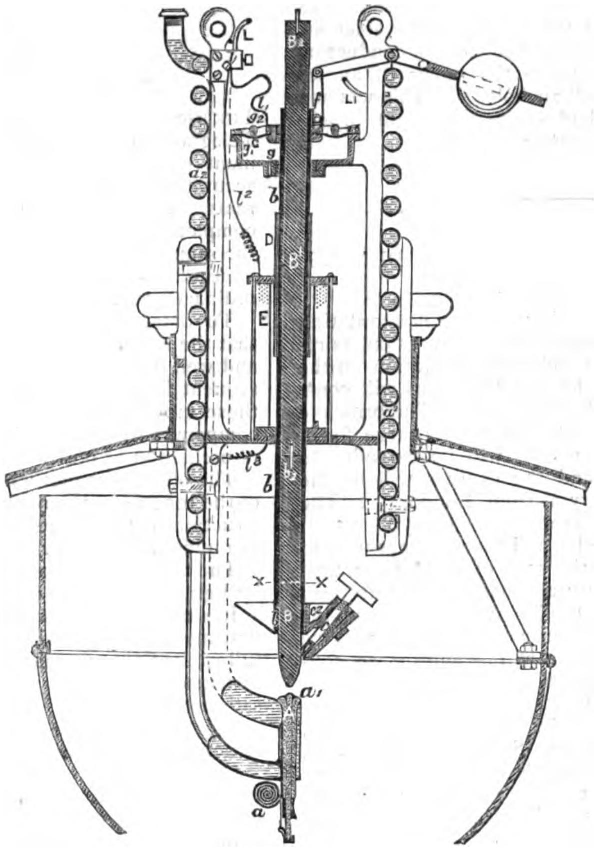
* Telegraphic Journal, February 15th, 1880, page 65.

SIEMENS' SINGLE CARBON ELECTRIC LAMP.

THE construction of this lamp, to which we referred in our last issue,* is as follows:—In the fig., which represents a vertical section of the lamp, A is the lower electrode, formed of an iron or steel wire loosely fitting in a water-cased tube, and pressed upwards by a volute spring, *a*, or by a weight and pulley. The mouth of the water-cased tube has a bush, a^1, closely fitting the wire A, or having a burr at its mouth, so as to prevent the wire from being pushed through it, except when its point becomes softened, fused, and dissipated by the heat of the voltaic arc. The water circulating through the casing of the electrode may flow to and from an open cistern, or it may, as shown in fig. 1, circulate through a closed coil of tube, a^2, presenting a considerable cooling surface. The upper electrode, B, is a carbon rod free to slide in a tube, *b*, having two internal ribs. At the lower end of the tube, *b*, is provided an oblique adjusting screw, C, the point of which bears against the carbon and presses it against the ribs on the opposite side of the tube, so that being in a manner clamped between these ribs and the screw, C, it cannot slide down. Moreover, from this pressure of the carbon against the ribs, *b*, close contact results, so that the electricity enters the carbon at its point of contact with the ribs, and consequently the heating of the carbon is confined mostly to the portion of it which projects below the tube. As the lower end of the carbon gradually wastes away from the point, C, the carbon gradually slides down the tube. The screw, C, may be of copper, as a good conducting material, or its point may be of refractory metal, such as platinum, or it may be a refractory gem, such as diamond, let into the point of the screw, C, which is guarded from the heat of the arc by a shield of porcelain or refractory metal. The screw, C, works in a shield, c^2, of convex or inverted conical form enamelled or faced with porcelain on its lower surface, so as to reflect the light as well as to protect the tube, *b*, from the heat of the arc. As the carbon, B, becomes consumed and descends down the tube, *b*, a fresh carbon, B^1, can be added to it; for this purpose the upper end of the one carbon is hollowed out a little, and the lower end of the fresh carbon is served with a little moistened sugar, or with tar, which, as the junction approaches the lower end of the tube, becomes carbonised by the heat, cementing the two carbons

* Stewart's Electric Lamp, page 80.

together. It is of advantage to provide in each carbon a short piece of wire, b^2, to act as a dowel, centering the carbons to one another; or the one carbon might be made with a point projecting as a tenon to enter a hole in the end of the other carbon. The automatic adjustment of the distance of the electrodes is effected in the following manner:—



SIEMENS' SINGLE CARBON ELECTRIC LAMP.

The tube, *b*, has on it, a cylindrical casing, D, of soft iron; or instead of a complete cylindrical casing, the iron may be put on the tube as a number of strips arranged round its circumference. Around the tube, *b*, is the coil of a solenoid, E, consisting of a great number of convolutions of insulated wire, so as to present very considerable electrical resistance. This solenoid coil forms part of a circuit connecting the one terminal with the other, as will be understood by tracing the course of the electrical current from the one line wire, L, to the other line wire, L^1. The one wire, L, is attached to an insulated connecting piece, *l*, from which a flexible metallic strip, l^1, connects to the tube, *b*, holding the upper carbon, and a wire, l^2, connects to the solenoid coil, E. The other wire, L^1, is connected directly to the frame of the lamp, which is all in metallic connection with the lower terminals, and also by a wire, l^3, with the solenoid coil, E. The tube, *b*, and its carbon being a little more than counterbalanced by an adjustable weight on a lever connected to the tube by a non-conducting link, *f*, the regulation of the distance of the terminals depends upon the

relative quantities of electricity passing through the voltaic arc between them and through the solenoid, E. When the terminals are too near each other, very little of the electricity passes through the solenoid, and the counterweight then draws the terminals apart; when they are too far apart a larger portion of the electricity passes through the solenoid, E, the iron, D, is thereby attracted down into the solenoid, and the terminals are thus brought nearer together. Should the lamp be extinguished so that there is no passage of electricity from the one terminal to the other, then the whole of the current passes through the solenoid, and the terminals being thus brought close together, the arc is re-established. In order to damp the oscillations that might result from the action of the solenoid, the tube, *b*, is attached to a flexible non-conducting diaphragm, G, which forms the cover of an air vessel, *g*, having a small air hole, g^1. This acts as a dash-pot, a ring, g^2, laid on the diaphragm, G, preventing it from bulging outwards.

TELEGRAMS ADDRESSED TO PLACES ABROAD.

THE Postmaster-General has issued a notice stating that under the St. Petersburg Convention, as revised in London, the following alterations in the regulations respecting foreign telegrams will come into force on the 1st April, 1880:—1. The principle of a word tariff, instead of a fixed charge for a minimum number of words, will be extended to European telegrams, and the charges will be the same from the country as from London. 2. The compulsory collation (repetition) of cypher telegrams will be abolished. 3. Proper names will no longer be allowed in the text of code telegrams, unless used in their natural sense. 4. In European code telegrams any of the languages in use in the different countries of Europe, or Latin, will be allowed; but no telegram will be allowed to contain words drawn from more than one language. In extra-European code telegrams, only the following eight languages will be allowed, viz., English, French, German, Italian, Spanish, Portuguese, Dutch, and Latin; but words drawn from any or all of these languages will be allowed in one and the same telegram. 5. The charges paid by the addressee for the repetition of an inaccurately transmitted telegram will be refunded. 6. Numbers written in words will be counted according to the manner in which they are written by the sender. For example, "Two hundred and thirty-four" would be counted as five words; but "Twohundredandthirtyfour" as two words in European telegrams (fifteen letters to a word), and three words in extra-European telegrams (ten letters to a word). 7. In extra-European telegrams, groups of figures or letters will be counted at the rate of three (instead of five) to a word. 8. The length of the reply to a telegram which can be prepaid by the sender will be limited to thirty words, and a form will be handed to the addressee enabling him to send a reply at any time within six weeks. Should the addressee not use the form, the amount paid for the reply will be returned to the sender, provided that the addressee returns the form within six weeks to the Post Office, accompanied by a request that the money may be refunded to the sender. In no case will the amount be paid to the addressee. 9. The charge for each copy (after the first) of a telegram containing a multiple address will be reduced from 5d. per copy of twenty words to 5d. per copy of one hundred words.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

V.

RELAYS.

The Post Office Standard Relay.

THE use of fast speed apparatus in the British Postal Telegraph Department has necessitated the employment of a form of relay which would respond accurately to a series of very rapidly reversed currents. The Standard Relay now in use answers completely to this special requirement, and being at the same time a very sensitive instrument and easily adjusted, is in many cases used for working on ordinary as well as fast speed circuits.

To obtain sensitiveness in a relay, it is essential that the moving parts should be as light as possible, and well balanced, so that no undue drag, and consequent friction, is put on the pivots of the same; those moving parts which it is essential should be comparatively heavy, should be set as near the axis of oscillation as possible.

The electro-magnet which causes the movement of the tongue of the relay should be of such a construction that it can receive and lose its magnetism as rapidly as possible.

The relay should not be liable to demagnetisation by lightning or other causes.

In designing the Standard Relay, all these, and the first-mentioned special requirement, have been carefully taken into consideration, so that a first-class instrument has been produced which gives most satisfactory results.

Figs 1, 2, 3, 4, 5, 6, 7, and 8 will enable the construction of the Standard Relay to be understood.

Of these figs., 1 is a plan of the instrument with the cover removed; figs. 2, 3, 4, 5, and 6 show various parts of the instrument, portions being omitted in each fig. to show the other parts more clearly.

Referring to fig. 4, which represents the armature of the relay, and referring also to the other figs., *a* is a brass rod, with steel pivots at each end; t_1 and t_2 are soft iron tongues fixed to *a*, and *t* is a thin brass tongue with a platinum contact piece, *c*, at its end. A thin spiral copper wire, *z*, has one end screwed to *a*, the other end being connected with the frame of the instrument so as to ensure good contact being made between the armature and the frame. The top pivot of the armature turns in the brass bridge, *b*, *b*, and the lower part turns in a hole on the brass bed plate, P_1, P_1; the end of the pivot, which is highly burnished, rests on a small polished steel plate, *v*. It is very essential that the lower pivoting should be done in this manner; if the shoulder of the pivot rested on the bed-plate, the

FIG. 1

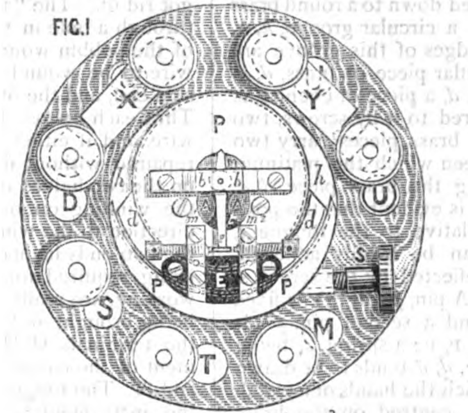


FIG. 2

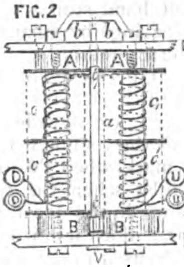


FIG. 3

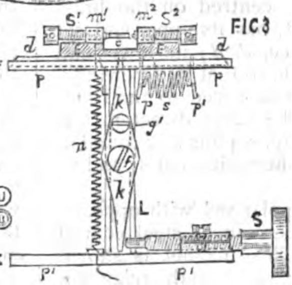


FIG. 4

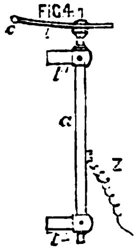


FIG. 5

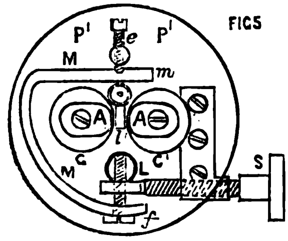
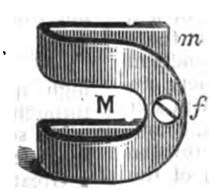


FIG. 6



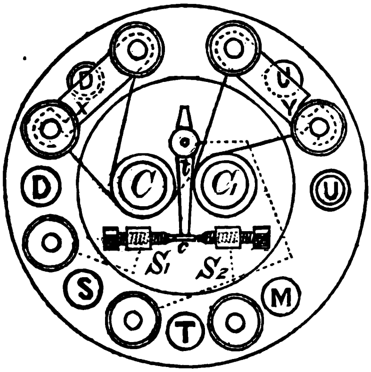


FIG. 7.

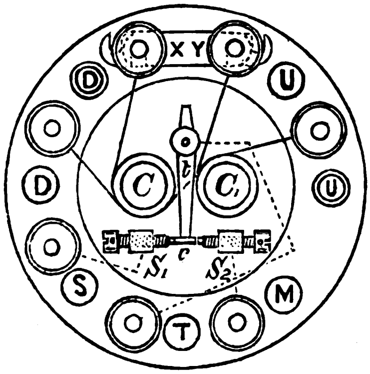


FIG. 8.

sensitiveness of the relay would be very greatly diminished.

The bridge, *b*, *b*, is screwed down to a round brass plate, P, P; this plate has a circular groove, *h*, *h*, turned in its surface; the edges of this groove are undercut V shape; a circular piece of brass, *d*, *d*, slides in this groove. To *d*, *d*, a piece of ebonite, E, is screwed, which has secured to it by screws, two brass pieces, m_1, m_2; these brass pieces carry two contact screws, S_1, S_2, between which the platinum contact, *c*, plays. By sliding the brass piece, *d*, *d*, round in the groove, *h*, *h*, it is evident that the position of the screws, S_1, S_2, relative to the tongue, *t*, and its contact piece, *c*, can be readily adjusted. The movement of *h*, *h*, is effected by the screw, S, in the following manner:—A pin, *p* (fig. 3), is fixed to the brass piece, *d*, *d*, and a second pin, p^1, is screwed to the brass plate, P, P; a spring, *s*, being hitched to *p* and p_1, the piece, *d*, *d*, tends to be drawn round in the direction in which the hands of a watch turn. A brass lever, *k*, *k*, centred on the brass pillar, L, L, by the screw, g^1, has its upper end set loosely in a hole in the piece, *d*, *d*; its lower end banks against the set screw, S, so that by screwing S forward, the upper end of *k* is moved to the right, thus moving *d*, *d*, round in the same direction. If S is unscrewed, then the spring, *s*, pulls *d*, *d* round in the reverse direction; thus the position of S_1 and S_2 can be finely adjusted.

The tongues, t_1, t_2, are polarised with opposite polarities by means of a permanent steel curved horseshoe magnet, M, M. This magnet is shown in perspective by fig. 6; its position in the relay will be understood from fig. 5. The magnet is secured in its place by three screws, one of which, *f*, is screwed into the brass pillar, L, L (fig. 3), a large hole being made in *k*, *k*, to allow the screw to pass through the latter without interfering with its movements. Of the other two screws, one, *e*, is seen in fig. 5, the other is immediately below it. The ends of these two screws rest in slight channels filed out in the magnet. The tongues, t_1, t_2, which are induced by the magnet, are not set opposite the extreme ends, *m*, but a short distance away from them, as seen in fig. 5. The reason of this is, that it is found that at a certain point away from the extreme ends, *m*, of the permanent magnet, magnetism is induced in the tongues, t_1, t_2, without the latter being strongly drawn towards the magnet; thus, whilst the tongues are properly induced, there is but very little drag, and consequent friction, exerted on their pivots. By screwing the screw, *e*, and the corresponding one below, backwards or forwards, the ends of the magnet, M, M, can be set more or less close to the tongues, t_1, t_2. It is found that there is a certain distance at which the relay is rendered most highly sensitive. The electro-magnets are formed of two bobbins, C, C, and C_1, C_1, with soft iron cores, and two soft iron pole pieces, A, B, and A_1, B_1. These magnets are secured by screws to the brass plates, P, P, and P_1, P_1. Each of the bobbins are divided in the middle by a division (fig. 2), the object of the latter being to enable the bobbins to be wound with the insulated wire without having "inside ends." Every one who has had to deal with electro-magnets knows the trouble that "inside ends" cause. If these ends are accidentally broken, the whole of the wire has to be unwound off the bobbin to get at them and repair the breakage. In winding bobbins provided with central divisions, this source of trouble is entirely got rid of. The "inside end" is first brought out through a hole in the central division, and one half of the bobbin wound with wire. The rest of the wire to be wound on is then connected to the inside end, and the other half of the bobbin filled up. Thus each bobbin has two "outside ends" to the wire, and if either is broken by accident it can be repaired without difficulty. In winding the wire on the two halves of the bobbin, care is taken that the winding on one half is done in the reverse direction to the winding on the other half, so that the two ends lie in opposite directions. The relays, being required for both "single" and "duplex" working, are really wound with two wires, the ends being brought out and respectively connected to the terminals U, U_0,* and D, D_0.* The arrangement of the connections will be seen from figs. 7 and 8. The tongue, *t*, that is to say, the frame of the instrument, is connected to terminal T, the left-hand stop screw, S_1, is connected to terminal S (spacing) by means of a small spiral of wire, *s*, and the screw stop, S_2, is connectedto terminal, M (marking), by means of a similar spiral wire (not shown in the fig.). The "marking" and "spacing" screws, S_1, S_2, are so called because in an ordinary local circuit the tongue works the local instrument, or makes it mark, when the former is over against the stop, S_1, whilst when the tongue is against S_2 no current flows in the local circuit, consequently the instrument does not work on "spaces." Terminal S is only used in certain cases, which will be explained in due course. The ends of the wires from the coils are connected to terminals, U, U_0 ("Up" line), and D, D_0 ("Down" line), in the manner shown.

X and Y are two brass straps which hinge on the two terminals, D_0, U. When these straps are in the position shown in fig. 8, then the coils of the electro-magnet are joined up in "series," so that a current passing between terminals, D and U_0, traverses the whole of the wire on the electro-magnets direct, that is, their whole total resistance is in circuit.

When the straps, X and Y, are in the position shown in fig. 7, the coils are joined up for "quantity," that is to say, the current passing between D and U_0 splits between the two coils of the electro-magnet, which thus has one-fourth of the resistance only which it would have when joined up in "series."

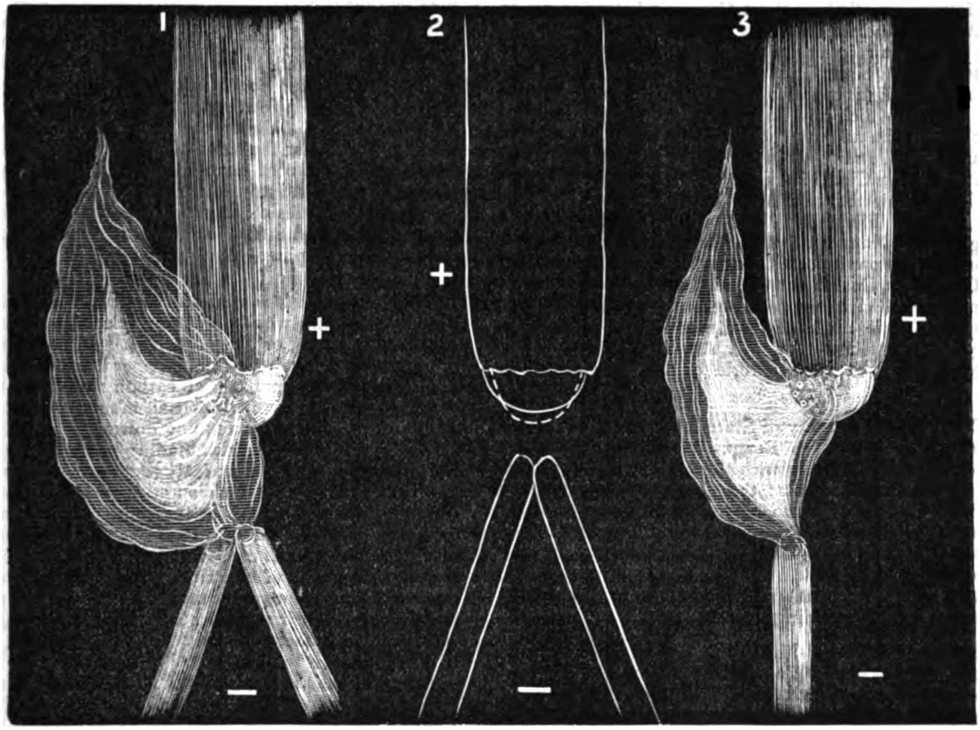
Each of the coil wires has a resistance of 200 ohms, so that when joined up in "series," the total resistance of the instrument is 200 $\times$ 2 = 400 ohms, but when joined up for quantity the resistance is $\frac{200}{2}$ = 100 ohms. The relay will respond at a high speed to a current of 1 milliweber passing through either of the coils. With both coils joined up in series, the instrument will work with a very much less current.

Great care is taken in winding the coils of the electro-magnet to ensure the two wires having equal resistances and being uniformly wound, so that if a strong current is sent through the two coils in opposite directions, a perfectly neutral result is obtained.

* U_0 and D_0 represent the terminals whose indicating letters have double circles round them.

CURIOUS VOLTAIC ARC EXPERIMENT.

WE lately had the pleasure of witnessing a curious experiment, made by Mr. J. Rapieff, with the electric-light arc in one of his three carbon lamps. The voltaic arc being started, the end of the upper, or +, carbon was touched with a piece of iron wire, which immediately melted, the molten portion clinging to the end of the carbon by capillary attraction. After a short time the carbon became cup-shaped at the bottom, the molten iron resting in the cup. On drawing out the arc, a curious phenomenon manifested itself, a cluster of small circles, or spots, presented themselves on the surface of the glistening metal, and flames radiated from them, which eventually lost themselves in the general flame. The drawings illustrate the effect in profile and nearly front view. The centre of the flame was of a yellowish tinge, merging into a beautiful purple near the edges. On disconnecting the circuit and allowing the carbons to cool, the iron commenced a pulsatory movement up and down, as indicated by dotted line of figure 2, and eventually fell to the ground.



Notes.

THE Edison telephone has been put on a line 27 miles in length, between No. 7, Sauchiehall Street, Glasgow, and Grangemouth, both offices belonging to the Glasgow and Rotterdam Steam Shipping Company. The results obtained are said, by the *Glasgow Herald*, to have been extremely good.

THE telephone has been utilised by the Leeds Corporation for connecting the Town Hall with the waterworks and the gasworks at Eccup and New Wortley respectively.

THE use of an electric bell without special wire, as a means of call in a telephone circuit, is objectionable, and various attempts have been made to use the telephone itself for the purpose. In an arrangement recently contrived by Dr. Wurstenberger, of Stuttgart, the plate of the receiving telephone is made to give out loud sounds by means of an ordinary induction coil. The primary coil at either station is brought into the circuit of a local battery by means of a Morse key, or otherwise, and the secondary coils in both stations are simply inserted in the telephone circuit. So long as the key is in the position of rest, it closes a shorter secondary circuit than the secondary coil of the inductor, so that the telephone currents are not weakened by the resistance of the latter. But on depressing the key the battery is brought into the primary circuit of the inductor, and a series of induction currents sent into the telephone line. (A figure of the arrangement will be found in *Ding. Pol. Jo.*, 2nd Feb. number.)

A NEW USE FOR THE TELEPHONE.—Hitherto it has been a matter of some difficulty to determine the time of flight of small-arm projectiles, owing to the impossibility of seeing them strike. In a series of experiments made by the U. S. Ordnance Department, this difficulty has been overcome by the use of the telephone. The telephone was connected with two Blake transmitters, one placed near the gun, the other in front of and near the target. The time between the report of the gun and sound of the ball upon the target was measured by a stop-watch. The observations, founded on a large number of experiments, never differed more than a quarter or half of a second from each other, the slight delay in starting the watch being neutralised by

the delay in stopping it. It was found that the time of transit was affected by the wind, being shortened by a rear and lengthened by a head-wind.—*Scientific American.*

The Telephone on the Tyne.—It is proposed to open a telephone exchange on the Sandhill, radiating to all parts of Newcastle, Gateshead, Elswick, Tynemouth, North and South Shields, Jarrow, Northumberland, and the Tyne Docks, &c. The system will be connected with merchants' offices. A subscription of something like £15 per year will give a merchant all the necessary accommodation. It is also proposed to have during business hours hourly reports of the arrivals and sailings of vessels, and all other sorts of useful information of shipping movements in the lower part of the river.

At the Hippodrome, 60 Jablochkoff lights have been hitherto used in conjunction with 20 Serrin regulators, the former supplied by three Gramme batteries of 20 lights each, and the latter by a machine to each lamp; 128 Jablochkoff lights are to be substituted, the same to be supplied by eight Gramme machines of sixteen lights each. This light has also been furnished to the paddle s.s. *Cosmos*, which now has eight lights from a Gramme machine of the new type. (See *Telegraphic Journal* of January 15th, *ante*.) It is also being used at the Usine Centrale de la Cie. Générale de Paris Horologes Pneumatiques, the Ateliers of MM. Jaeggé, Perrard, in Paris, the Usine à Plomb of M. Normand at Nantes, the Magasins de Nouveauté of M. Chauloinneau at Angers, Fabrique de papier of M. Lacroix, Angoulême, Usine du Creusot at Chalon sur Saône, the Theatre Roman at Montpellier, Chantiers of M. Herseux at Brest, likewise at the Filature of M. Eug. Bauer e Soci at Varallo, Italy; the warehouse of Mr. Antill, at Portsmouth, England, and at the Sucrerie of M. Vandesmet at Rio de Janeiro.

The Under Secretary of State for France has authorised the Ministry des Beaux-Arts to light the forthcoming Salon at Paris with the Jablochkoff light. It will be remembered that the Company lit last year's exhibition with 256 lights, having in the course of seven days and nights supplied steam-power, wires, and sixteen batteries of sixteen lights each. Between the 7th and 30th of the same month that the light was installed, 117,509 persons, each paying his franc, visited the Salon during the evening hours.

In December last, M. Berly, the engineer of the Société Générale de l'Electricité, conducted a series of experiments to ascertain the best method of supplying the Victoria station at Westminster with electric light from the shed at Charing Cross. He had two circuits, with five lights in each, and first used the up rails as return wires for one, and the down rails for the other. Afterwards he tried one up and one down together for each circuit, with equally good results in each instance. Latterly he has connected the two wire circuits, placing in the centre thereof (at Charing Cross) five lamps, thus making a complete wire circuit of seven miles, with the lamps in the middle of it. The light emitted was apparently of about the same strength as five similar lights on a short circuit.

The Albion Mills, Halifax, belonging to Messrs. J. Crossley and Sons, are now lighted on trial by the Brush electric light. It is at present applied only to the carding and combing shed, a building with an area of 200 feet by 135, and hitherto lit by 230 gas jets. Fifteen Brush lamps are employed. The Brush light is being tried for lighting purposes at the Liverpool Street Station of the Great Eastern Railway.

The *Superb*, 8,760 tons, 7,430 h.p., completing for sea at Chatham Dockyard, has been fitted with the electric light apparatus, with which experiments are now being made. The *Swiftsure*, 6,660 tons, 4,913 h.p., at Devonport, and the *Thunderer*, 4,987 tons, 6,270 h.p., at Malta, are also being fitted with apparatus for the electric light.

Electric Light Battery.—Although the production of the electric light by the incandescence of carbon has been pronounced by some scientists wasteful, it is still held in favour by amateur electricians, and the form of lamp devised by Werdermann is now largely used by them. The current for these lamps has generally been generated in a nitric acid battery, such as those of the Grove and Bunsen type, but grave objections have been raised against these on account of the nitrous fumes given off by them whilst in action. To overcome these objections, an amateur has recently devised a cell which may be thus described:—A porous pot is well paraffined top and bottom; into this is put a cylinder of well-amalgamated zinc, which dips into a layer of mercury at the botton, and the cell is filled with acidulated water. The outer pot is charged with strong nitric acid; into this dip four strips of platinum foil attached to a brass ring. Under the ring, but over the foil—pressing it against the sides of the pot—fits a wooden cover saturated with paraffin. Several of those cells are put in a box, into the corners of which are placed unstoppered bottles of ammonia when the battery is in action. It is said that this device prevents all nitrous fumes from escaping.—*Design and Work.*

The *Scientific American* illustrates an electric lamp patented by the well-known electrical inventor, Mr. Moses G. Farmer, of Newport, R. I. A globe made of glass, and having an air-tight stopper fitted to its lower end, contains a small bar of carbon supported by two large blocks of the same material, mounted on the ends of two bars of metal extending downward through the stopper, and provided with binding posts for receiving the wires from an electrical generator. Two small tubes enter the globe, through the stopper, for the purpose of substituting for the common air contained in the globe a vacuum or an atmosphere of some suitable gas. The small carbon rod offers great resistance to the passage of the electrical current, and is consequently heated to incandescence, and produces a brilliant light without consuming either itself or the gas contained in the globe.

An excellent article, by Dr. A. Tobler, on the duplex telegraph systems in England has been published in the *Journal Telegraphique.*

Mr. Henley writes to us to call attention to a slight error in our mention of his new company in the last issue of this journal. The title of the company is "W. T. Henley's Telegraph Works Company, Limited."

The Telegraph in Japan.—The s.s. *Glenorchy*, which arrived here on the 21st December, brought nearly fifty miles of submarine telegraph cable for the Japanese Government. The greater portion of this is intended for another cable across Tsugar Straits, to connect Hakodate with the main island, and is now being discharged temporarily into the M. B. M. s.s. *Saikio Maru*. The other portion—consisting of nine miles of heavy shore end—will be discharged at Kobe, and is to be employed in laying another cable between No-o-mura in Sikoku and Sibu-kawa, in Bisen, on the main land, a distance of six miles. It will be remembered that a wire was laid last year between the two

places mentioned, by the *Meiji Maru*, but, whether done wilfully, for the purpose of theft, or accidentally from the anchors of junks, faults are continually occurring. It has therefore been decided to lay an extra-strong cable across, which will be too heavy to lift, except with proper apparatus, and the *Meiji Maru* has again been selected for the work. She left for Kobe on December 23rd with the telegraph staff and the necessary gear, in order to complete the needful arrangements, previous to the arrival of the *Glenorchy* at that port. Whilst on this trip, the *Meiji* will also lay an extra wire across Simonosaki Straits.—*The Japan Herald Mail Summary.*

THE number of telegrams received and sent by French offices rose from 3,600,000 in 1868, to over 11 millions in 1878, and last year it must have certainly exceeded 12 millions. The French telegraphic net work had, in 1869, an extent of 113,669 kilometres, and at the end of December last year its extent was 171,500 kilometres.

DIGNEY AND LARTIGUE'S RAILWAY ALARM SIGNAL.—This invention consists of a steam whistle fixed on the engine, and worked by electricity. The whistle is connected with an insulated metallic brush, which is placed under or at the side of the engine. At the side of the line or between the rails there is a fixed metallic contact, about 7 feet long, faced with copper, which is in communication with the positive pole of a battery. The negative pole of the battery is in communication with a commutator on the signal post, from which a wire [illegible] direct to earth. As long as the signal is at "line clear" the passage of the brush over the fixed contact produces no result, but when the signal is set to "danger" the commutator brings the negative pole of the battery in direct communication with earth, and, on the brush passing over, establishes a circuit, and causes the whistle to be sounded. The fixed contact can be fixed any required distance from the signal. This system obviates entirely the danger of running past the signals by reason of fogs, snow-storms, or other causes, and has been adopted with perfect success by the Great Northern Railway of France.

PATENTS FOR INVENTIONS BILL.—In the House of Commons, on Wednesday last, Mr. Anderson moved the second reading of the Patents for Inventions Bill. He said much of the depression in English manufactures, and a great deal of the increasing prosperity of foreign manufactures, was due to the encouragement which foreign nations gave to patentees in comparison with England. Our neighbours sought to stimulate the inventive genius of their people by a cheap system of patent law, while we rather checked such attempts. Every session the amendment of this law was proposed, and the Government introduced bills on the subject, but these bills seemed to create a kind of police to keep patentees in order, and prevent them getting any benefit from their inventions. He would compare our particular manufacturing competitors with England in the charges made in connection with these laws. In Germany, which, after England, charged most, a person could get a patent for a first payment of 30s.; and the subsequent payments up to twelve years made a total of £196 10s. Thus, the heaviest charges were thrown on the latest stages of the working of the patent, the very point on which our Government erred most. In Belgium a patent could be obtained on a first payment of 8s.; a second, three years afterwards, of £4; a third, two years afterwards, of £4, and up to the end of the twelfth year a total of £36 8s. was the entire charge. In America a patent could be obtained for 35 dollars, and that was all it cost for twelve years. In England the initial charge was £12 10s.; at the end of the third year a charge of £62 10s. was made; by the end of the seventh year the patentee had to pay £162 10s., and by the end of the twelfth year £262 10s. The fees were not the only expense to which a patentee was put, for he had to pay endless sums for experiments, and it was absolutely impossible for him to bear heavy charges for fees in the earlier stages of his invention. The bill now before the House proposed a modification of the present charges. It also proposed that paid commissioners should be appointed to manage the Patent Office. That office was at present dreadfully mismanaged. Patentees had the utmost difficulty in ascertaining what previous discoveries there were affecting their inventions. In order to give facilities in this respect he proposed that, in place of the present unpaid commissioners, who did not do the work at all, there should be paid commissioners. The bill also proposed to extend the time during which patents ran, to twenty-one years, instead of fourteen, this provision to apply to existing patents as well as to those which might be granted in the future. He trusted that the House would consent to the second reading of the bill, in order that its principle might be affirmed, as he believed it would stimulate the inventive genius of the country.

After some discussion the order for the second reading was discharged.

We are informed by Mr. Barlow, the well-known patent agent, that Switzerland, which hitherto has had no patent law, has now taken a step in that direction by passing a "trade marks act."

A NEW CABLE.—The s.s. *Calabria*, belonging to the Telegraph Construction and Maintenance Company, sailed on Saturday, Feb. 28, with 511 miles of cable on board, to lay between Manilla and Hong Kong.

Review.

Lightning Conductors, their History, Nature, and Mode of Application. By RICHARD ANDERSON, F.C.S., F.G.S., Member of the Society of Telegraph Engineers. London: E. and F. N. Spon.

(*Continued from page* 70.)

IN France, in the year 1823, a report on Lightning Conductors to the "Académie des Sciences" was drawn up by six of the most eminent electricians of the day. In this report, which contained a large amount of information, the well-known theory that "the upper rod of a lightning conductor—that projecting over the roof—will be an efficient protection against lightning within the circular area of a radius double that of its height" was propounded. This theory seems to have been accepted as such an absolute one, that there is scarcely a book on physics yet published which has not stated it, or has ventured to express any doubt as to its correctness. The acceptance of the truth of this rule, Mr. Anderson points out, "led to the erection of monstrously huge rods made to tower high above buildings, so as to increase the field of protection to the largest possible extent."

The recommendations in the report proved so faulty, that in 1854 a new committee of six were appointed, which drew up a fresh "instruction," in which many of the previous conclusions were re-

vised, and amongst them the theory of the fixed area of protection. It seems strange that the withdrawal of this theory has not been observed by scientific authors; probably this is due to the fact that the theory has been copied from book to book, as it first stood, without each author having taken the trouble to find out whether any change of opinion had taken place in the mean time.

In the 1854 report, the use of copper conductors is strongly urged, as is also the necessity of the joints between the various lengths of rod being well soldered.

A third report was published by the "Académie des Sciences" in 1867. In this report the necessity of a yearly inspection of the lightning conductors was urged with much stress, and it was also strongly recommended that a special report should be made at each examination. The advice has been followed, with the result, says Mr. Anderson, "that at this moment the public buildings of France have the most complete protection against lightning—greatly in contrast with the public buildings in England."

The contrast between the energetic action of the French authorities, and the apathy of those concerned in England is very marked, and were it not for the untiring perseverance of the late Sir William Snow Harris but little would probably have been done during the last half century; as it was, however, lightning conductors came to be extensively adopted on the ships of the Royal Navy, and with the greatest advantage, and also in many cases on buildings, and especially on powder magazines. The present Houses of Parliament are protected by a most efficient system of conductors, designed by Sir William Snow Harris.

In a chapter on "The Best Material for Lightning Conductors," Mr. Anderson strongly recommends, and with reason, copper-wire ropes as being the best protection against lightning; these ropes should be of copper of high conductivity, and this kind is manufactured in large quantities by Messrs. R. S. Newall for the purpose.

The importance of the "earth connection" and the proper way to ensure its being good is fully considered, and a special chapter is devoted to the question of the "inspection of lightning conductors." In speaking of this question the author says, "It is lamentable to think that while the regular inspection of lightning conductors has been admitted long ago to be a necessity in many countries on the continent of Europe, we as yet have taken no steps whatever to realise it." The importance of the subject is thoroughly appreciated by scientific men we should fancy, but the necessity of it has hardly been urged strongly enough, and we fear that until some catastrophe occurs in consequence of neglect of the necessary precautions, no steps will be taken in the matter; but until the time arrives when the nation comes to its senses on the matter, those who feel that they are living in danger of having their dwelling brought down about their ears, either from their residence being provided with a possibly faulty system of protection or from not being provided with any protection at all, cannot do better than purchase a copy of Mr. Anderson's work, which they will find will both interest them and give them practical information, it being the best book on the subject yet published. In conclusion we must say that the "get up" of the work is all that could be wished, being done in Messrs. Spon's well-known excellent style.

Proceedings of Societies.

PHYSICAL SOCIETY.—FEBRUARY 28th.

Professor W. G. ADAMS in the chair.

A PAPER was read by Mr. RIDAUT, on "Some Effects of Vibratory Motion in Fluids." It was found by Savart and Tyndal that jets of water were sensitive to notes or air vibrations like flame, and the author conceived the idea of vibrating the jet of water from within. To do this he caused an electro-magnetic arrangement to pinch the tube conveying the water 400 to 500 times per second, so as to communicate a vibratory motion to the stream of fluid. The issuing jet spread out in two streams, beautifully broken into drops, and representing the fundamental note. When the pinching-lever vibrated irregularly harmonies were observed. When the water was thrown into vibration in two different planes the resulting jet rotated in the tube.

Froude's deduction, that a liquid moving in a tortuous tube has a tendency to straighten the tube, was illustrated by oscillating a pipette with its nozzle.

Professor PERRY explained this action by the hydrodynamical fact, that the pressure is less at the centre of the mouth of the cup than at the edges.

Professor GUTHRIE said that he had tried a similar experiment with a funnel-shaped mouth and a glass cone, but failed. He surmised that perhaps the cohesion of the water for itself, as it formed a shell round the ball, might help to cause the success of the ball method.

Professor ADAMS pointed out that with the cup and ball there was less difference of head of water between the centre of the mouth and the edge where the water escaped than with the funnel.

Dr. STONE stated that he had been able recently to imitate many physiological sounds, such as the murmur of the heart, by means of constructions in tube through which water and air were flowing. His demonstrations were made before the Royal College of Physicians.

Dr. C. W. WRIGHT then read an important paper on a "Determination of Chemical Affinity in Terms of Electro-motive Force." After giving a history of the subject he described his original experiments. They consisted in performing electrolysis of sulphuric acid and measuring the heat evolved in the process and by recombustion of the materials. A voltameter with spade-shaped platinum electrodes soldered to st[illegible] copper wires, and sealed by a large plug of gutta-percha, was employed for the electrolysis. An ordinary water calorimeter was used to measure the heat given off, as Bunsen's was found to contain sources of loss of heat. The strength of the current employed was va[illegible] from 6 webers to $\frac{6}{10}$ weber. The volume of gas produced was measured by Joule's plan. Radiation [illegible] was corrected for by three methods. From an average of eighteen experiments the value of e, the electromotive force, was found to be 1·5038 C. G. S., or v[illegible]

Taking the formula $J = \frac{e}{(H + k)x}$ where J [illegible] Joule's equivalent, H is the heat actually evolved [illegible] the heat evolved by recomposition, and x a constant

which Kohlrausch gives the value of ·000105, the author proves that Joule's equivalent should be $4·196 \times 10^7$, instead of $4·20 \times 10^7$, as given, to render the formula correct. The author thinks that Joule's water friction experiment gave the truest value of J, and that his electric heating experiments gave a result about ¼ per cent. too low, owing to the B. A. unit of resistance being about 2 per cent. too high, and from other causes.

THE SOCIETY OF TELEGRAPH ENGINEERS.

At an ordinary general meeting of this Society, held March 10th, Mr. W. H. PREECE, President, in the chair, a paper by Mr. ALEXANDER SIEMENS, on "Recent Improvements in Electric Lighting Apparatus," was read by the SECRETARY.

The preliminary portion of the paper gave a cursory description of the general progress which had been made in electric lighting during the last few years. One of the most important improvements that had been made in dynamo-electric machines, consisted in making one machine act as the excitor to the other machine, the latter giving out the working current; this had been done by Wilde and Ladd.

In 1867, Wheatstone suggested the plan of employing a shunted portion of the current to excite the inducing magnets of the dynamo machine. This device seemed to answer all requirements. The resistances of the armature and the inducing magnets of the machine devised by Wheatstone were high, so that there was no danger of the apparatus becoming damaged by being short-circuited, for when so short-circuited, the inducing magnet became inactive, and thus no current, or very little, would be produced.

Where expense was to be avoided, the use of a separate excitor for the machine was objectionable, as as it was costly.

It was pointed out that a comparatively high resistance in the lead wires caused the lights to burn steadier, as a considerable variation in the arc-resistance produced a less total effect on the total resistance in the circuit.

Alternate current machines were the most economical.

A recent improvement in dynamo machines, effected by Messrs. Siemens, consisted in the abandonment of the iron core on the rotating armature. The effect of this was to very considerably reduce the heating of the wire, and but very little diminution in the effective power of the machine was caused by the alteration.

. The progress made in electric lamps could not be considered to be satisfactory. It was a pity that inventors, before bringing out new ideas, did not find out what had been previously done by referring to Major Bolton's list of patents, given in No. 27 of the Society's *Journal of Proceedings*.

Incandescent lamps enclosed in exhausted globes, it was pointed out, dated back to 1845.

Reynier's and Werdermann's lamps were very steady, but not economical, as a great deal of the current was not utilised. The Jablochkoff candle was not quite satisfactory, since if it became extinguished, it did not re-light automatically as the end to end carbon lamps did. The latter form of lamps were the ones most extensively used, and could be made to burn a very long time. New inventions and improvements in lamps were principally in this direction of simplification.

Several lamps had been designed by Messrs. Siemens—viz., the Hefner-Alteneck lamp,* the pendulum lamp,* with the bottom carbon fixed (this form of lamp had been used most successfully at Blackpool); the double solenoid lamp.† Modifications of the foregoing had been made in which the fixed carbon was made movable by being pressed upwards by a spring against a point pressing sideways against the end of the carbon.‡ Good carbons were very essential in order to produce a steady light.

As regards the cost of the light compared with gas, it was stated that, at the Albert Hall, a saving of 60 per cent. was effected; at Blackpool a saving of 54 per cent. Several other calculations were given in which the saving was shown to be from 47 to 87 per cent.; but, at the same time, it was stated that gas companies need be under no apprehension that they would be superseded.

As regards the question of storage of electricity, it was pointed out, that although electricity itself had not yet been stored, yet motive-power had and could be, which practically amounted to the same thing.

In conclusion, Mr. A. SIEMENS stated that the electric light could now be fairly said to be a success.

A vote of thanks having been unanimously accorded to Mr. A. Siemens for his paper, a discussion followed, in which

Mr. CROMPTON explained his improved lamp, which was shown in action, and was remarkable for its steadiness. This result was obtained by the mechanism being made very sensitive and light, so as to respond very quickly to variations of the current. Mr. Crompton stated that he had found it impossible to use the earth in the place of a return wire, on account of its variable resistance.

Mr. HEINRICHS then exhibited and explained his lamp.§

M. ANDRÉ then gave an explanation of his incandescent lamp. The principle of this invention consisted in enclosing the incandescent carbon in a glass globe, which was sealed by means of a water-joint; the air was not exhausted in the globe, but the oxygen of the air was allowed to burn itself out by the combustion of the carbon; when all the oxygen was consumed, then the carbon ceased to burn, and only wasted away very slowly from mechanical disintegration.

Mr. ANDREWS next gave a description of a lamp he had devised, which consisted of carbon plates with their faces parallel and close together. In this case the arc formed between the edges of the plates.

The meeting then adjourned.

New Patents—1880.

814. "Telephone wires or cables." J. H. JOHNSON. (Communicated by F. A. Gower.) Dated Feb. 24.

832. "An improvement in or connected with electric lamps." Honourable R. T. D. BROUGHAM. Dated Feb. 25.

834. "Improved moorings for buoys, specially applicable to buoys used for marking positions in connection with the laying of telegraph cables and with marine surveying." W. C. JOHNSON and S. E. PHILLIPS. Dated Feb. 25.

* *Telegraphic Journal*, Dec. 15th, 1874, page 393.

* *Telegraphic Journal*, Oct. 1st, 1879, page 319.
† " " Dec. 15th, " " 413.
‡ Siemens' single carbon electric lamp, see page 98 of this number.
§ *Telegraphic Journal*, Sept. 15th, 1879, page 301.

842. "Means or apparatus for producing the electric light." A. M. CLARK. (Communicated by Messrs. Bouteilloux and Laing.) Dated Feb. 25.

849. "Improvements in dynamo-electric machines, and in apparatus used therewith." H. J. HADDAN. (Communicated by C. F. Brush.) Dated Feb. 26.

860. "Manufacture of magnetic appliances and garments." G. GREEN. Dated Feb. 27.

872. "Improvements in magneto-electric and dynamo-electric machines, parts of which improvements are applicable also to other purposes." D. G. FITZGERALD. Dated Feb. 28.

878. "Pneumatic telegraph apparatus." W. MORGAN BROWN. (Communicated by Count G. de Monti.) Dated Feb. 28.

885. "Machinery for producing motive power and lights by the means of electricity." J. GRADDON. Dated Feb. 28.

886. "Apparatus for obtaining electricity." C. W. HARRISON. Dated Feb. 28.

899. "Improved combined galvanic batteries and medicated pads for the cure of bodily diseases." A. M. CLARK. (Communicated by H. E. Hunter.) Dated March 1.

905. "Improvements in covering wire with insulating material, and in apparatus for that purpose." J. C. L. LOEFFLER. Dated March 1.

925. "Electric lamp." J. H. GUEST. Dated March 2.

931. "Apparatus for communicating between the passengers in railway trains and the guards or engine drivers." H. MORRIS. Dated March 2.

941. "Improvements in and connected with transmitting and intensifying sound for telephonic purposes." R. H. COURTENAY. Dated March 3.

954. "Improvements in and relating to automatic or mechanical organs and harmoniums, and apparatus or means for playing or performing upon the same and upon pianofortes or other instruments by the aid of electricity, or magnetism, or otherwise." J. T. SMITH. Dated March 4.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

2497. "Transmitters for telephones." ALEXANDER MARR. Dated June 21. 4d. Instead of vibrating diaphragms of thin sheets of metal with solid or powdered carbon between, the inventor uses diaphragms made of wood, preferably pine, inside which diaphragms and near the centre, he attaches a disc or discs of solid carbon in close proximity to each other, or he fills the space between two wooden diaphragms with powdered carbon.

2654. "Telegraphic apparatus." E. COOPER WARBURTON and LOUIS JOHN CROSSLEY. Dated July 1. 6d. Relates to a relay for use with Bright's bell instruments, and to polarised telegraphic relays generally. *See* p. 96.

2656. "Immersing submarine cables." AUGUST BLONDOT and JULES BOURDIN. Dated July 1st. 6d. Is intended to facilitate the laying of cables, so that there may be no kinks and no great strain between the submerged part and the remainder of the cable. The cable is wound with regularity on a drum, to which the movement for unwinding is given by gear which is capable of varying the speed. At the stern of the vessel is a pair of delivery rollers with a caoutchouc surface, and driven by a shaft of the drum with the aid of two intermediate devices, viz.:—First, a round strap which passes over the drum, and has an independent tightening device; and, secondly, a brake analogous to those employed to obtain a regular tension of the thread in a sewing machine.

2674. "Telephones." SYDNEY PITT. Dated July 2. 1s. 4d. (A communication from abroad, by George Lee Anders, of Boston, U.S.A.) Consists in a district telephone system of a series of switches, each of which normally short-circuits the telephonic apparatus, and is adapted to establish an earth connection at each station on either side, according to the direction of the communication, without breaking the continuity of the line. Also to enable a bell to be rung at one of the several stations on an electrical circuit at the will of the operator, at the station from which the signal is given, without ringing the bell at any of the other stations.

2697. "Indicating in railway carriages the names of stations, &c." F. M. ROGERS. Dated July 3. 2d. Consists of a dial with pointer, or a drum or roller, upon which the names of the station, or the numbers expressing the names of the stations, are made apparent. By means of a permanent or polarised electro-magnet a wheel or detent attached to the pointer or drum is caused to move forward or backward one step when a current is sent through the wire connecting the various indicators with the guard's van, in which is placed an ordinary key or automatic current sender, so arranged as to actuate the indicator when entering a station.

3001. "Insulated wires and cables." WALKER MOSELEY. Dated July 23. 2d. Proposes to surround the wire or cable with twisted strands of horsehair, then to saturate the whole with melted resin or gum, with a little oil to toughen it. Afterwards to enclose it in a double sheathing of copper or other metal, with tin or composition between the double sheath. (*Provisional only.*)

3023. "Telegraph wires." J. H. JOHNSON. Dated July 25. 4d. (A communication from Eldridge Wheeler, of Pa., U.S.A.) Consists of a telegraph wire with a core of steel, Bessemer steel or homogeneous iron, and a clothing of wrought iron welded to the steel, the advantages claimed being great strength and cheapness compared with wires in common use.

City Notes.

Old Broad Street, March 11th, 1880.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO.—The ordinary meeting of this Company was held on the 2nd inst., at the Cannon Street Hotel, Sir Daniel Gooch, Bart., M.P., the chairman, presiding. The secretary (Mr. W. Shuter) read the notice. The chairman said: In moving that the accounts and the report be adopted, I need not detain you very long, because the affairs of the Company are set out fully in the report, which I have no doubt you have all read. You will see that during the past year we have manufactured 6,917 miles of cable. The result in money is that we show a net profit of £98,988, after deducting interest charged upon our debentures. We brought forward from the previous year an amount of £59,353, making together £158,341 to dispose of. Out of this we gave an interim dividend of 5 per cent. in July, amounting to £22,410; and now the directors propose to distribute, as dividend, 15 per cent. for the last half-year, £67,230, carrying forward to next year £68,701.

That, I think, gentlemen, is a very satisfactory statement of the financial working of the past year. (Hear, hear.) The work done is set out in Paragraph A. First, the duplicate Australian cable, which we began very early in the year, but the completion of which was postponed in consequence of the necessity that occurred for carrying out the Cape contract. The Australian Government were good enough to postpone the completion of this cable in order that the Australian cable might be utilised towards completing the Cape cable. Therefore we did not complete the Australian cable till within the current year almost. Then Paragraph B refers to the Cape cable, and you will see that 3,845 miles were successfully laid; but, unfortunately, a break has taken place since in the shore near Mozambique, and there was no ship nearer than Aden for the purpose of repairing it; but we have information to-day that the ship has arrived on the ground, and I have no doubt in a day or so the cable will be made right. It is a bad bit of ground where the cable has broken, and some means will have to be taken by the Cape Cable Company to see if they cannot find a better piece of ground outside the existing route. Then we have started a ship, the *Calabria*, with 555 miles of cable to be laid between a point near Manilla, in the Island of Luzon, and Hong-Kong, and that will be completed in the month of May, that is for the Eastern Extension Company. Then we have carried out a contract with the German-Norwegian Company to make and lay a cable between Arendal, in Norway, and Hoyer, on the coast of Schleswig, and this operation was completed in August, amounting to 256 miles. Then, in December last, we entered into a contract for a short cable for the New Zealand Government of about 120 miles, and the cable is now laid and the ship is on her way home. The total amount of cables made has been 6,917 miles. We are, I think, indebted to those officers and others who have been engaged in laying these cables, for the care and ability with which they have completed their work. It is a very large extent of cable to lay, and we have had no misfortune of any kind to record. Of course the accounts are set out in their full detail. I shall be glad to give any explanation of them, but I do not know that I can do any good by repeating them. You have them in the paper before you much clearer than my explanation would be. I don't know that I can say more than that we hope our present prosperity may continue. Perhaps it will not be quite so great as it has been; but, at any rate, so far as your directors are concerned, they will do their best to carry on the work satisfactorily. The chairman concluded by reading the formal resolution for the adoption of the report and the declaration of the dividend. Mr. Philip Rawson seconded the motion. In answer to Mr. Abbott, the chairman said: Mr. Abbott is not quite right in supposing we have laid 6,617 miles of cable during the year. That was the quantity manufactured, but the whole of it was not laid in the year. The Australian cable was not laid within the year, and the accounts of the Australian cable do not come into this account at all. I mentioned that before, but perhaps Mr. Abbott did not catch what I said. As I have told the shareholders on many occasions, the success of this Company hitherto has been due to the fact that we have large funds in hand. If we had not had large funds in hand we could not have laid the Cape cable. It is pretty well publicly known that the Telegraph Construction Company had to take two-thirds of the capital of that cable upon its own hands, and the Eastern Company took the other. If we had not had these large available amounts at our command we never could have undertaken it; therefore, although they look large sums to keep in hand, yet our success depends upon having large sums in hand. Of course I am as deeply interested as others in getting large dividends. I want them very badly, like everybody else; but I look to the prosperity of the concern, not for one year, but as a permanent investment, and I am sure the course we take is the wisest course, and it has hitherto been the successful course. I don't think anybody can complain of 20 per cent. I wish I had that in everything I am connected with. Therefore I hope the shareholders will not inquire too closely into the figures of that account, but will trust the directors, who have never yet deceived them, and who, if times become hard, will tell them of it. I do not propose to give the details of our securities. They are shown generally in the state of the balances, and I hope the shareholders will accept them in that shape. The report was then adopted unanimously.

Mediterranean Extension Telegraph Co.—The half-yearly general meeting was held on the 3rd inst. at the City Terminus Hotel; Sir James Carmichael in the chair. The secretary read the advertisement convening the meeting, and the report of the directors was taken as read. It stated that the last half-yearly balance sheet of the Company showed a slight improvement over that of the previous half-year. The cables were in good condition. They recommended payment of the usual dividend at the rate of 8 per cent. per annum, less income-tax, on the Preference Stock, and of a dividend at the rate of 3 per cent. per annum, free of income-tax, on the Ordinary Stock of the Company, on and after the 10th March, leaving a balance of £48 to be carried to the reserve fund. The revenue account showed that the receipts from messages during the half-year ending the 31st of December last had been £2,281, and the amount due from the Government under the guarantee was £3,600. The chairman, in moving its adoption, regretted the delay which had occurred in holding the meeting, and said it had arisen through the official auditor of the Treasury demurring to a portion of their claim for payment of the guarantee. They had tried to get the matter settled before the meeting, but it was still under the consideration of the Treasury. He hoped, however, that at their next meeting he should be able to make a favourable report on the subject. The motion having been seconded, Mr. Robinson thought the shareholders should remonstrate with the Government, who, he said, were imposing very onerous terms on the Company, and seemed to dictate to the board what they should do and what they should not do. Seeing the difficulty they now had in getting messages from the Government, he supposed that when the guarantee expired they would get none at all. The shareholders took no heed of the position of the Company, but imagined that the dividends they were receiving were to be continued for ever. Looking at their prospects, he thought they should add to the articles of association a power enabling them to grasp some other line or to make an arrangement with some other company. The chairman, in reply, said the agreement with the Government had nearly four years to run. Seeing that the Government could end the guarantee, it was surely not their interest to quarrel with their paymaster. The Government had paid them fairly and liberally, and he had not found them hard taskmasters. The present Government was not answerable for having sanctioned the competing line referred to by Mr. Robinson. Mr. Campbell (the solicitor of the Company) said he hoped they would be able to come to an amicable arrangement with the Government on the point at issue. The chairman thought Mr. Robinson had made a valuable suggestion, and it was arranged that if anything occurred which was likely to affect the Company beneficially they might call a meet-

ing before the next half-yearly meeting, but if not the next meeting could be made special to take the powers suggested. The report was unanimously adopted and the dividends recommended were declared.

The Direct United States Cable Company (Limited).—Report of the proceedings at the fifth ordinary general meeting of the Direct United States Cable Company (Limited), held at the City Terminus Hotel, Cannon-street, on Friday, 27th February, 1880, at twelve o'clock, noon; John Pender, Esq., M.P., in the chair. The notice convening the meeting was read. The Chairman: Gentlemen, as you have had the report in your hands for some days, I presume you will take that as read. I should like in the first instance to make a few remarks as to the figures in the report, in order, if possible, to make it so clear that there may be no difficulty in discussing it on its merits. It will be seen from the Company's accounts that our revenue for the half-year to 31st December last, after deducting rent of land lines and payment to Anglo Company, amounted to £120,445 8s. 6d.; and the working and other expenses, including debenture interest and income-tax, absorb £25,001 3s. 6d., leaving a balance of £95,444 5s. as the net profit of the half-year, making, with £2,345 1s. 5d. brought from the previous half-year, a total of £97,789 6s. 5d., which has been appropriated as follows:—Two interim dividends of 5s. each per share for the quarters ended the 30th September, and 31st December, 1879, together requiring £30,355, have been paid; an amount of £48,942 2s. 9d. has been added to the reserve fund (which is thereby increased to £150,000); the sums of £1,900 on Preliminary Liquidation and Arbitration Account, and £914 7s. 1d., the cost of removing spare cable, have been written off, and the balance of £15,677 16s. 7d. is carried forward to the next half-year. Our revenue in the past half-year, as compared with that in the corresponding period of 1878, has increased by the sum of £30,501 13s. 10d. This satisfactory result is mainly owing to the revival of trade between this country and America. The working and other expenses show a balance of increase of £3,250, which is accounted for as follows:—Compromise of Colgate suit, including law and other charges incidental thereto, £2,560. I think it is right I should explain to you that this Colgate suit is the reversion of an old patent which was obtained in America, and a claim in respect of royalty upon the covering of copper wire with gutta percha. That patent existed in this country, but expired many years ago. The American patent in some way or other had been in existence at a later date, and, curiously enough, the inventor, or rather, the trustee of the inventor, took the question up and gained a decision in more courts than one in America. Therefore, that involved a compromise; but, fortunately for us, we got out of the matter by that compromise at a comparatively small expense. I believe that the trustee of the inventor in America has got a very large sum of money from land lines in America in virtue of that patent. Then there is the opening and furnishing new stations in America and building in Ireland, £830; extra printing and stationery, £410; maintenance and renewal of instruments, £360; debenture issue and miscellaneous, £720; making a total of £4,880. But, as against this increase, there are many items of decrease, amounting to £1,630, leaving as net increase of expenditure £3,250. Omitting from these details the special expenditure *re* Colgate, it will be seen that the other items of increase were unavoidable, inasmuch as without the extra outlay it would have been impossible to earn the largely increased revenue. The above explanation of the increase in our expenditure, &c., having been given, no other item in the accounts appears to call for special remark. (Applause.) Now, gentlemen, I hope I have put before you very clearly the state of our finances, and I think I may congratulate the shareholders on their very satisfactory character. Therefore I need trouble you no further with these details. No doubt there are gentlemen in the room who may require to ask some questions on those accounts. If so, I shall be very glad to reply to any criticisms that may be made upon them. I may also congratulate you on the fact that since April last our cables have been working in every way satisfactorily, and the result has been the large return which your accounts show. I have no doubt that there are many gentlemen present who will be naturally anxious to know how we stand in relation to the new French cable. (Hear, hear.) It may be in your recollection that six months ago I gave you an outline of the French competing scheme. Since then the line has been completed, but I can scarcely say yet that it is open for general traffic. Messages have passed over the line, but at the present moment the telegraphing public know very little about it, and I suspect those who are immediately interested in the cable know a great deal more than it would be pleasant for them to communicate. So far they are very much in the position which I indicated—they are doing no good for themselves, but they are inflicting damage to a very considerable amount on telegraphy generally. I also stated six months ago, when those shares were at a premium in France, that in my opinion before twelve months were over they would be at 50 per cent. discount. I saw those gentlemen who formed the syndicate, for I went to Paris for the purpose of doing so, because I thought it was only right that those men, who must be ignorant of telegraphy generally, should be informed on the subject. I found one of them sitting at his desk with his pen in his hand, and I told him to make this note—that in twelve months, if I then returned to France, I should be able to sympathise with him on the loss of 50 per cent. of his property. To-day I can prove the truth of the prediction, for I now hold in my hand an official quotation from France, made only yesterday, which states that the shares have been sold at £11 each, which is close upon 50 per cent. discount. We may infer, therefore, gentlemen, that the cable manufacturers, the syndicate, and the French public generally, are in no way satisfied with their bargain. The contractors have pretty well exhausted England, as you who formed this Direct Company know. For three years the shareholders got nothing out of this Direct Company; and the syndicate lost £550,000. I have no doubt at all that if the new French cable were to fall into better hands, those better hands would probably by business-like arrangements be able to bring about the same result which has been brought about on our system; but then, gentlemen, it will be at a loss of about 50 per cent. on the original cost of the cable. As I have said they have exhausted England, I may say that they have pretty well exhausted France by this time also; and we are informed that they next propose to try Belgium, and, if that fails, Germany. But I should say that after the two attempts which have been made by the same parties, in which they have so signally failed in carrying out the promises made in their prospectuses they will find out that other countries are not likely, particularly Germany, to engage in such a losing game. Schemes, such as the French cable scheme, are got up, as you are aware, by contractors and syndicates simply for the purpose of getting money upon the transaction, regardless of all consequences to telegraphy or to the investing public. Within a year they may get up a company, and within a year they may lay the cable, and hand it over to the company;

the public lose their money, the contractor probably puts something into his pocket, unless he has taken the amount of his contract in shares, and the result is that he goes elsewhere to find out another field for his enterprise. When telegraphic enterprise was first started, syndicates were a necessity, as it was almost impossible to get money from the general public; but now that telegraphy is established as a commercial necessity, and its real value ascertained, the public are not likely to subscribe for any enterprise unless they see a return commensurate with the risk. I have always held at public meetings of telegraph companies which I have had the honour of addressing that submarine telegraphy ought to pay from 8 to 10 per cent. dividend. I hold the same opinion now. It is a very curious fact, if you look at the telegraph companies generally, that the public estimate and value the telegraphic enterprises pretty much at that rate. No doubt in the early days of telegraphy 10 per cent. was necessary; but now that the public estimate the value of the telegraphs more accurately, and consider them more secure as a property, the returns are less. I may say that the telegraph returns upon the price which you can buy them at to-day give something like from 6 to 8 per cent. The amount of money at present invested in cables is about £25,000,000; the amount of reserve fund put aside by all the telegraph companies amounts to £1,630,000; but to replace the deep sea portions of these cables, an amount of £12,500,000 would be required, and until this amount is obtained, it would not be wise, in my opinion, to consider submarine telegraphy in the sound position in which its friends would wish it to be placed. On this point I think it necessary to be very clear and distinct, so that there may be no misunderstanding betwixt shareholders and directors. The Direct Company's cable has been laid nearly six years; for three years, as you are aware, it paid no dividend, and put aside no reserve. It has been nearly three years under the present direction, and in that time we have paid you a dividend of 5 per cent., and have accumalated an amount of £150,000 for a reserve. Had the proper course been pursued from the beginning, and a proper reserve laid aside, we should have at the present time £300,000 as a reserve fund. The average life of a cable is said to be ten years, but as to this, much depends upon the bed on which the cable is laid. I believe it would be difficult, if not impossible, to raise a cable from 2,000 fathoms after being ten years under water; still, it is quite possible that a deep-sea cable might live for twenty, thirty, or forty years, or even longer, so far as the insulated core is concerned, because in all our raisings of cables that have been in the sea for a very considerable time, we find that the gutta percha is almost indestructible, as far as sea water is concerned. As that is the life and heart of a cable, if you could only get armour-plating sufficiently strong to resist the action of the sea water, a telegraph cable, might live for a very long period. However, let us assume the life at ten years. The reserve necessary to replace the deep-sea portion of our cable in that time would be £52,300 per annum, but if we raise the life to fifteen years, we should require £32,300 per annum. I think, gentlemen, the safer principle to go upon is to put aside the larger sum, and when we exceed the ten years, and our cable is still living and in a profitable working state, then the Company can afford to pay a very considerably increased dividend, or probably it would be better to give bonuses. I submit, therefore, that the policy, not only of this Board, but the policy of all Boards of submarine telegraph companies, should be to accumulate a large reserve. There is another point I must touch upon, and that is the often-expressed desire in certain quarters for reduced telegraph rates. Now I think I have shown you that a reserve fund is a necessity to secure permanency of telegraph property, I think I can now show you that the reduction of rates from the commencement of telegraphy has been very striking indeed. When the telegraph was first established, the tariff across the Atlantic was £20 a message; it has gone down steadily, and now an average message costs 30s., in fact, a message can be sent across the Atlantic for 9s. When we reflect upon the ingenuity of the code and packing systems, we find that the amount of matter that can be transmitted at this low rate is almost beyond calculation. I may repeat what I have often stated at these meetings—if we had now an open system instead of the code system to deal with, for the matter which is passed over our lines we should realise the most sanguine anticipations entertained in the early days of telegraph property as to dividend. I remember myself, in the very early days of telegraphy, talking with Mr. Cyrus Field, and his saying that nothing less that 50 per cent. would satisfy him as a proper return for these telegraphic cables. That was a very sanguine view; but, if the open system had been continued to-day, it would have proved pretty much what he stated. But the ingenuity of the coding and packing system has reduced us, as I will show you, to a very low dividend indeed. It is the public who have really got all the benefit of the telegraph. If we take the capital of all submarine cable companies at the present moment, we find that the amount is over twenty-five millions sterling, and taking all the dividends that are earned upon these twenty-five millions, we find it to come out at only 4½ per cent. It would, therefore, I hold, be unsound policy, both in the interests of shareholders and of the telegraphing public, to talk of reducing rates at the present moment. We must remember that a submarine cable can only carry a certain number of words, and, taking the working time of a cable, it requires 3s. a word to give but a very moderate return upon the invested capital in these Atlantic systems. So far as the Atlantic tariff is concerned, any reduction leading to an increase of messages would not lead to a larger return in money, because at a low rate it would be impossible for a cable to carry the number of words required to make it pay. To carry messages at a low rate, additional cables would be required, which, of course, involves additional outlay of capital and reduction of dividends. The present tariffs are in no way checking telegraphy, as we may plainly see, if we take last year as an evidence, for there is a large increase in the return of telegraphs generally. As I have often said, telegraphy is the best barometer we have of trade. With good trade, the returns rise rapidly. With bad trade, they become correspondingly depressed. The increase in the telegraph companies' returns is one evidence which I think we have all good reason to congratulate ourselves upon at the present moment, that not only in America, but also in India, and, in fact, throughout the world, trade is getting into a brighter and sounder position; and that is an evidence which I believe will brighten many a home. (Hear, hear.) We must deal in this question of telegraph tariffs with averages, and I hold that the rates we are now charging are a fair average, and must be maintained until the reserves I have indicated are secured. Having now shown you by figures that it is desirable to largely increase the reserves, and that it is undesirable and impolitic to reduce tariffs, I will just say one word as to the position which submarine telegraphy occupies at the present moment, and what it has had to contend with. Telegraphy has had little or no support from governments. Governments have never hesitated to grant concessions to anybody who might apply for them,

encouraging, as they say, competition. They even go so far as to prevent any cable landing upon their shores (I am speaking of England, France, and the United States) which hold any concession or special privileges, while they do this, throwing every obstacle in their power in the way of submarine telegraphy (and I should be glad to have an opportunity of proving this to the governments) becoming a remunerative enterprise, although they admit it has become a great necessity both for Imperial and commercial interests. But instead of dealing with it on the same principle that they deal with their own telegraph systems, which in every country is a vast and close monopoly, they are strict to a degree in upholding their own monoply, but they lose no opportunity of destroying what they are pleased to term the monopoly of submarine telegraphy. I hope the governments will see these things in their proper light, and that they will consider well when concessions are asked for whether they are sought in the interests of the public generally, or are meant to enrich speculative contractors, to the destruction of sound telegraph enterprise. Telegraphy does not admit of undue competition. It has had to be established at enormous cost, and is of a very speculative and uncertain nature. Until science has done more than it has yet done to render cables permanent, the greatest caution ought to be observed on the part of governments, and I may say also on the part of individuals, in order not to destroy the fabric which has done so much, not only to promote commercial interests, but civilisation, to a degree more rapid than anything that has yet been known in this or any other time in the history of the world (Applause.) Gentlemen, I have felt it necessary to-day to give you a few details, which I dare say will be interesting to you, as showing the position in which telegraphy is at the present moment. I believe that the value and usefulness of telegraphy is only beginning to be felt at the present moment. Great as the benefits are which it has conferred upon mankind, there are still greater benefits to be conferred by it; and I think that all those who have been interested in telegraph enterprise from the beginning may congratulate themselves upon the fact that they not only have had a moderate dividend, but they also have the satisfaction of knowing that their property is an increasing property, and that they have conferred an enormous benefit upon the commercial interest and the public generally. (Hear, hear, and applause.) Gentlemen, having troubled you with these few remarks, I beg to move the following resolution :—"That the report of the directors, dated 13th February, 1880, together with the statement of accounts to the 31st December, 1879, annexed thereto, be, and the same are, hereby received and adopted." Mr. W. Ford seconded the resolution. Replying to Mr Jackson and Mr. Newton, the Chairman said: Mr. Jackson has entirely endorsed the policy of the Board. He has asked the Board to stand on that policy; but he has stated that so far as our cable is concerned, we are in a very uncertain and very unsatisfactory position. I do not agree with Mr. Jackson in that respect, because our arrangements with the Anglo-American Company are of a very satisfactory nature. We should have ample time to repair our cable if it were to break, without suffering in any way in our dividends. At the same time, were it to break in deep water, there is no doubt at all that we should require to find a new cable. Our cable is still young and healthy, and I think it is in that position which, if it were to break to-morrow, as we have got a very good nest-egg to begin with, and plenty of time to repair it, and sufficient shallow water, that would limit the amount required for the cable to a very small proportion indeed. I take, therefore, a much livelier and brighter view of our position, so far as our own cable company is concerned, than Mr. Jackson does. We are, certainly, the junior partner; but we are supported by all the means and all the powers of the Anglo Company with regard to help in case of need. I do not go in for monopoly: I have always been opposed to monopoly. When we extricated this Company from its troubles, we were most decided in that view; we felt that to be absorbed by the Anglo Company was simply giving place for another cable to spring up. As long as I have the honour of being chairman of this Company, it will never be considered a monopoly, as I am opposed to monopolies altogether. I say that submarine telegraphy is a matter of enterprise, and is not ground to be poached upon by any other class of property. It is an uncertain property, as we all know, and that man who came forward to induce other people to find money to lay cables where they could get a better security for half the price at the same moment, shows that the public are still what I will call very gullible indeed, but I hope that every day is opening their eyes in that respect. With reference to Mr. Newton's question, I was going to make the reply which Lord Monck did, which I think was a very sound and proper reply. Only last night, in the House of Commons, a question was put to one of the ministers, and the minister's reply was, "During negotiations it would not be to the public interest that anything should be said about it." During the present stage of negotiations between the French and English companies, I think the less said about it the better. (Hear, hear.) All I can say is, that they are doing nothing, and, with a large capital lying unemployed, every day is strengthening our position and weakening theirs. You may depend upon it, when it comes to close quarters, if a bargain is ever made, that the interests of the shareholders of this Company will be fairly protected. The resolution was then put and carried unanimously. A vote of thanks having been accorded the Chairman, the proceedings then terminated.

The following are the final quotations of telegraphs :—Anglo-American, Limited, 59¾-60¼; Ditto, Preferred, 88-89; Ditto, Deferred, 32¼-32¾; Brazilian Submarine, Limited, 7¾-8; Cuba, Limited, 8¾-9¼; Cuba, Limited, 10 per cent. Preference, 16-16½; Direct Spanish, Limited, 2-2½; Direct Spanish, 10 per cent. Preference, 10¾-11¼; Direct United States Cable, Limited, 1877, 11-11¼; Scrip of Debentures, 100-102; Ditto, £25 paid, 1-3 pm.; Eastern, Limited, 8⅞-9⅛; Eastern 6 per cent. Preference, 12-12½; Eastern, 6 per cent. Debentures, repayable October, 1883, 103-106; Eastern 5 per cent. Debentures, repayable August, 1878, 101-103; Eastern, 5 per cent., repayable Aug., 1899, 101-103; Eastern Extension, Australasian and China, Limited, 8⅞-9⅛; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 100-102; Ditto, registered, repayable 1900, 101-103; German Union Telegraph and Trust, 8½-9; Globe Telegraph and Trust, Limited, 5½-5¾; Globe, 6 per cent. Preference, 11¼-11½; Great Northern, 9⅜-9⅝; Indo-European, Limited, 24-26; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 10-11; Submarine, 230-240; Submarine Scrip, 2-2¼; West Coast of America, Limited, 1⅞-2⅛; West India and Panama, Limited, 1⅝-1⅞; Ditto, 6 per cent. First Preference, 7½-8; Ditto, ditto, Second Preference, 7-7½; Western and Brazilian, Limited, 7-7¼; Ditto, 6 per cent. Debentures "A," 98-101, Ditto, ditto, ditto, "B," 97-100; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 34-35; Ditto, 6 per cent. Bonds, 104-108; Ditto, Second Bonus Trust Certificates, 2⅞-3⅛; India Rubber Co., 13½-14; Ditto, 6 per cent. Debenture, 106-108.

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THE ELECTRIC LIGHT BY INCANDESCENCE.

IT has been said that it is possible so to manipulate estimates by means of figures as to make their comparative values to be anything we please. Looking at the numerous calculations which have been made to prove the superior commercial value of the electric over gas lighting, or the reverse, we may well believe that this is the case, as, in spite of all that has been written and spoken on the subject, we seem to be as far as ever from arriving at a just solution of the much-vexed question. At the present time, the question of the arc *versus* the incandescence light, excites considerable differences of opinion amongst practical men. As regards steadiness and simplicity of mechanism, or rather the absence of the latter, the electric light by incandescence bears off the palm; and were it not for the question of cost being unfavourable to the incandescence system, it would leave the arc light very far behind, or rather would throw it out of the field altogether. Several of the so-called incandescence lamps are really partially arc lights—the Werdermann system for example—and in this field there seems special room for progressive improvement. At the last meeting of the Society of Telegraph Engineers it was stated that recent improvements had effected an economy of 100 per cent. in the Werdermann light over the results previously obtained with that system. It was admitted by Dr. Siemens that the candle-power obtained with the Werdermann system per horse-power was very high, that is, supposing the stated values arrived at as the result of experiments were correct. Dr. Siemens has said that the electric light by incandescence can never be as economical as the light by means of the arc; but in this case he alluded to a purely incandescence light as obtained by the heating of a wire or a strip of carbon; considering, however, how erroneous certain predictions as to the possibility of sub-dividing the electric light have turned out, and notably in the case of the Jablochkoff system as at present applied on the Thames Embankment, we may well hesitate to accept the opinion of Dr. Siemens as conclusive, even in spite of the present collapse of Mr. Edison's late experiments.

As regards the general question of electric lighting, there seems to be a general consensus of opinion that the special field for electric lighting is that in which large areas are concerned where it is possible to give uniform illumination by means of a few lamps. At the meeting before referred to, the *space* illuminated was strongly insisted on as being a factor which it is necessary should be taken into consideration when estimating the comparative values of various means of illumination. It has been often noticed that in cases where a small number of electric lights have been employed as a substitute for a larger number of gas jets, that the intermediate space between two electric lights has been in comparative gloom, although the areas in close proximity to the lights has been brilliantly illuminated; where a more numerous number of gas jets were used this disproportion did not exist, so that the comparisons were not just. There can be no question but that in striking a comparison between the electric light and gas there are other factors besides those generally used in making an estimate which must be taken into consideration, and which materially modify the problem, and, until it can be decided what these factors are, it is almost useless attempting to make estimates.

In a paper recently read before the Franklin Institute on the Edison electric light, several points in connection with the latter were mentioned which show how delusive ordinary photometric measurements may be. Speaking of the Edison light, Mr. Outerbridge says :—

"The light from the best lamps is certainly very bright when you *look at it* (it is hinted that the photometric measurements of the lights were made in this rough manner), but the simplest test of its illuminating power is to turn your back upon the source of light, and look at the space brightened by its influence. This trial I found to be an effective check upon any rising enthusiasm in regard to the illuminating value of the light, as compared with a good gas burner. The difference in this respect between the ordinary gas jet and the carbon horseshoe light seems to me to be tersely expressed in the vulgar phrase, that the Edison light is 'too thin,' *i.e.*, while the light from the gas flame proceeds from a large quasi-solid body of luminous particles of carbon, the light from the carbon horseshoe proceeds from *a very thin filament;* it is as though you should cover a gas flame with a little screen which would reveal merely a narrow rim of light; of course the illuminating power of the gas flame would be greatly decreased unless the incandescence of the narrow edge could be increased to a corresponding degree."

Though not attaching any undue importance to the foregoing statement, it will show that something has yet to be learnt on the subject of the science of illumination.

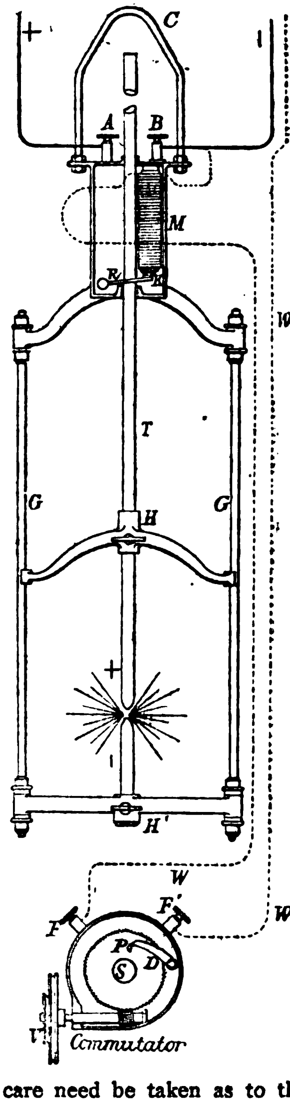
BROCKIE'S ELECTRIC LAMP.

THIS lamp has been designed to overcome many of the imperfections inherent in regulators, and constitutes an important departure from the principles upon which such apparatus have hitherto been constructed. Mr. Brockie having boldly discarded the well-worn principle of regulation by current strength, and with it all the delicate, expensive, and fickle mechanism usual in regulators, has satisfactorily solved the problem of producing a cheap and reliable electric lamp. The new principle and feature of this lamp consists in its periodical re-adjustment, by means of a commutator which cuts out the lamp magnet at stated regular intervals, quite independent of the current strength. This commutator may conveniently be worked by the engine driving the dynamo-machine, and is arranged to cut out the lamp magnet momentarily at short intervals, say about every minute, and it is during this momentary cutting out that the re-adjustment is effected.

Referring to fig. 1, the construction and action of the lamp will be readily understood. The carbons are placed vertically, the upper holder, T, being free to fall by its own weight; a cross head, H, sliding between the guide bars, G, is generally added to the holder, to ensure the carbons being kept directly opposite, and to prevent them overlapping or passing each other. A magnet, M, placed in a branch, W, of the main circuit, controls the upper holder by means of a sudden grip clutch, R. A commutator driven by the engine is placed in this branch circuit, and is timed to interrupt or break the same at regular intervals, say every minute. The action is as follows:—Suppose the carbons are touching—a current is now sent, the branch magnet, M, becomes active and pulls up its armature and the clutch, R, carrying the holder upwards a short distance, thus the arc will be established. The commutator presently cuts out the branch circuit and magnet, the armature therefore falls, together with the holder, the latter continuing its fall until the carbons meet, but as the magnet is instantly re-established the carbons are again separated as at first; after the lapse of about one minute, or other interval which may be arranged, the same operation takes place, and so on until the carbons are consumed, thus the arc is re-adjusted at regular intervals independent of the current strength. It is found in practice that no material increase in the size of the arc takes place during the time the carbons are locked, indeed there is less variation in this respect that in regulators of the Serrin type, where every alteration in the strength of the current has its reflex in the altered size of the arc; however, even this small difference may be prevented by a trifling addition to the lamp, but for all practical purposes no such addition is necessary. It might be thought that when the carbons meet momentarily, a blink or diminution in the light would take place; but the operation of re-adjustment is performed so quickly that no inconvenience is experienced, and the light is practically, absolutely steady. It is found that during the fall of the contact piece, D, from the pin, P, to the disc, S (only one inch), the re-adjustment is effected with certainty.

It will be seen that the carbons in this lamp cannot possibly run together permanently, even although the current should materially decrease, this being a fatal fault in all lamps depending upon current strength for their regulation, and one which gives much trouble to the users of the electric

Fig. 1.

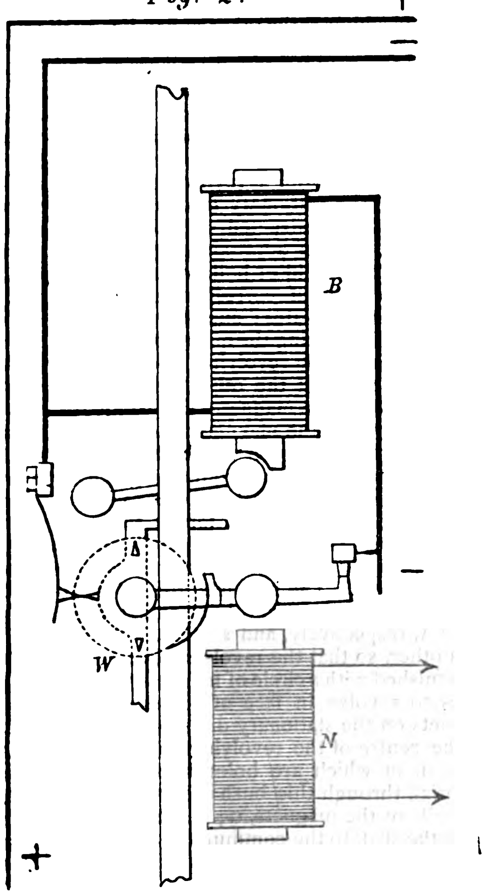


light. No care need be taken as to the speed of the engine, as far as regulation of this lamp is concerned, as the speed may be altered even fifty per cent. without putting it out of gear, a most important advantage in any lamp, and one which no regulator possesses; this feature, together with the simplicity of the lamp, constituting the chief advantages of the system.

Several lamps may be put in circuit and regula-

ted simultaneously, or by putting each lamp magnet in a different branch they may be re-adjusted at different times, so that the main circuit resistance will be more uniform than if all the lamps were re-adjusted at the same time; however, by a modified magnet arrangement, only one shunt and commutator need be used to re-adjust many lamps at different times. Fig. 2 shows this arrangement. The re-adjusting magnet, B, is placed in the main circuit, and a second magnet, N, is used to short-circuit it; this latter is placed in the regulating shunt with the commutator. A small wheel, W, is partially rotated by the pawl, P, at each impulse of the second magnet; this wheel only allows the short-circuiting of the main magnet after a certain number

Fig. 2.



of impulses of the shunt magnet, or at certain points in its revolution, thus, by setting the wheels in the various lamps in circuit at different points, each lamp will be re-adjusted at a different time, although all the magnets are excited simultaneously.

Messrs. Johnson and Phillips, the manufacturers, inform us, that the lamps have been designedly left for hours under the charge of men who were not instructed further than to keep the engine running, practically without a governor, so confident were they that no skilled supervision was necessary; indeed, no lamp we have seen appears to us to be more simple and certain in its action, or less liable to derangement, and will, no doubt, take a leading place amongst the few successful systems of electric lighting. The cost of the lamp and commutator is, we believe, about half that of any good regulator at present in use; the additional expense of a small leading wire to the lamps being inconsiderable, and no objection to the system.

STEWART'S ELECTRIC LAMP.

No. 2.

The advantages which this lamp possesses may be thus enumerated :—

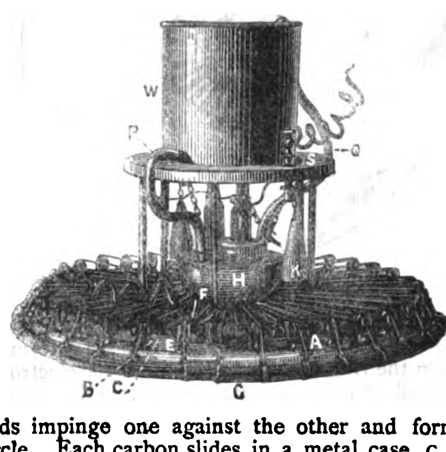
1. It is automatic in its action.
2. It is capable of burning for a very considerable period.
3. It does not throw any shadows.
4. It is of simple and comparatively inexpensive construction.
5. The intensity of the light may be increased if so desired.

A general view of the lamp is shown by fig. 1, and an underneath view by fig. 2.

A is a disc of wood or other insulating substance having a circular opening in its centre.

A number of square carbon rods, B B, are placed radially upon A in such a manner that their inner

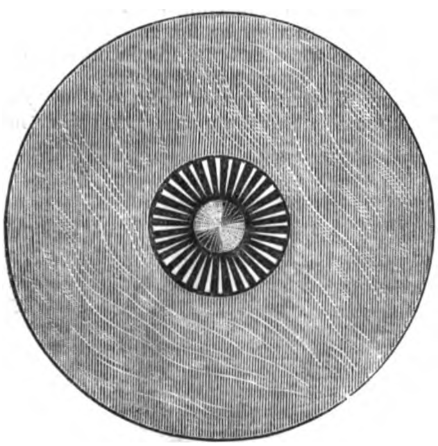
Fig. 1.



ends impinge one against the other and form a circle. Each carbon slides in a metal case, C, and is forced forward as it is consumed by means of a cord, D, attached to the outer end of the carbon. Each cord passes round a smooth brass ring, F, near the centre of the lamp and runs over a pulley, E, to the iron hoop, G, to which it is attached. The iron hoop, G, is for the purpose of exerting an equal strain upon each of the cords, D D. The carbon rods, B B, are all electrically connected with the positive pole of the dynamo-machine by means of the binding screw, R. H is the negative electrode, and consists of a covered hemispherical cup of copper, through which there is a flow of water from the

cistern, W. The water is conveyed to and from the cistern by means of the flexible tubes, P and Q, and serves to keep the metal electrode cool. Before the electric current passes into the lamp the electrode, H, is resting upon the ends of the carbon rods, B B. When the current enters the lamp it passes through the carbons, B B, into the metal electrode, H, partly along the chain and pulley, L, and electro-magnet, I, and partly along the chain and pulley, M, to the binding screw, S, which is in electrical connection with the negative pole of the dynamo-machine. The magnet, I, thereupon attracts the armature, J, and so lifts up the electrode, H. The electric arc is then formed between one or more of the carbons, B B, and the metal electrode, H. The weights, K K, attached to the chains, L and M, are for the purpose of balancing the electrode, H. The carbon rods, B B, burn evenly away, but the circle formed by their inner ends is not altered in form or size, as the weight of the hoop forces each carbon forward in turn, the amount of carbon consumed in each case being very small. Should the lamp cease to burn, which is very unlikely, it is instantly rekindled by the magnet ceasing to act and consequently allowing the metal electrode to touch the carbons, when the electric circuit is immediately re-established, and the electric arc reformed.

Fig. 2.



The lamp is supported by the cords, T T, from the ceiling of a room, and as the electric arc is formed between the ring of carbons and the metal electrode the lamp does not cast any shadow, as is the case in other lamps. The intensity of the light from this lamp may be increased or decreased by dividing the carbons into groups or sets, each set being insulated from the others and supplied by distinct currents of electricity. In this case switches would have to be provided for connecting or disconnecting the different sets in accordance with the number of currents employed.

It is evident that if a lamp of this description were to be constructed on a very large scale it would burn for a very considerable period of time without requiring any attention.

The lamp is the invention of Mr. Charles Stewart, M.A.

ELMORE'S DYNAMO-ELECTRIC MACHINE.

The object of this machine is to obtain by improved arrangements and construction of parts a greater extent of the magnetic field of the revolving armature, and so to generate a greater amount of electricity than can be produced with machines of other forms, and also to provide means for the governing the current and cooling the magnets.

The construction of the apparatus is shown by figs. 1, 2, 3, 4, and 5, and is as follows:—A, are end standards, having broad, circular surfaces, and serving as stationary discs, these are bolted to a bed plate, B, the standards having central bosses through which passes the central main driving shaft, C. On the inner surface of these bosses, the stationary magnets, D, are radially arranged in a manner to be more fully described later on. The shaft, C, carries a pulley on one end, to which is connected the driving machinery, the other end of the shaft carries the commutator, E, the extremities of the shaft being supported by bearing standards, B[1], fixed to the bed plate, B. On the main shaft, C, between the standards, A, is mounted a disc, F, upon both sides of which are bolted radial magnets, a number and size required according to the area of the disc; the disc when so fitted constitutes a revolving armature. The magnets of the stationary discs and the revolving armature are constructed as follows:—Two soft iron plates, *a*, *b*, of approximately sector form, are connected by a solid or hollow connecting piece, *c*, of steel or iron of corresponding shape to, but smaller than, the plates; one of the plates, *a*, serves as a flange for bolting the magnets, G and D, respectively, either to the revolving disc, F, or to the stationary disc, A, and the other, plate *b*, acts as the soft iron face of the magnet. The connecting piece, *c*, of the plates of the magnets is hollow or solid, and serves as the core upon which the wire is wound. In small machines, the connecting piece or core may be solid; the connecting piece of the stationary magnets, D, is, in all cases, longer than that of the revolving disc magnets, G, so as to receive a longer coil of wire; in fig. 3 the cores of the magnet, D, are shown hollow. The magnets are bolted in a circle on to and around the revolving and stationary discs, F and A, respectively, and are relatively opposite to each other, so that the revolving disc will carry and be furnished with a circle of magnets upon each face, so as to revolve in face of corresponding sets of magnets on the stationary discs, A, of the standards.

The centre of the revolving disc is fitted with a bush, H, in which are holes lined with insulating material, through this bush are passed the wires of the coils of the magnets, G; these wires are carried along the shaft to the commutator, E, thence through a perforated bushing, H, fixed on the shaft, C, which works in the boss of the standard, A. The wires are insulated by passing them through small tubes of insulating material, as will be understood by reference to figs. 3 and 5.

The wire upon the opposite stationary magnets is wound and connected in such manner as to give opposite polarity to each magnet facing the other, and so forming pairs between which the armature revolves.

For machines of large construction, and where larger currents are to be developed, the number of the armatures, F, and the stationary magnet

Fig. 1.

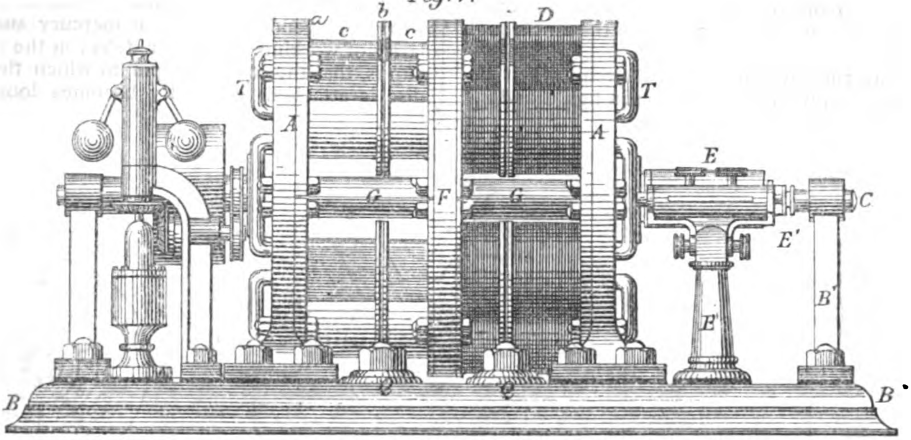
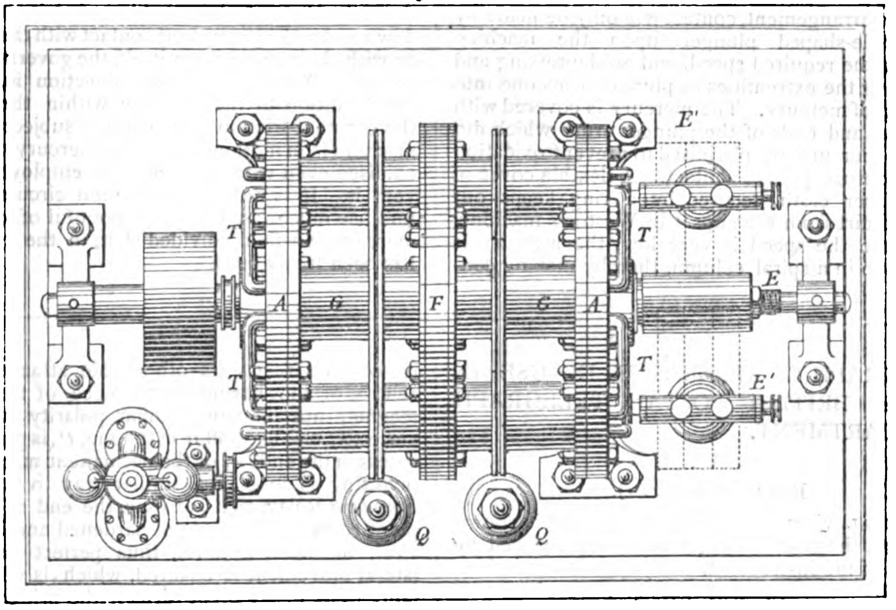


Fig. 2.



standards, A, may be increased; thus, for a machine having two of the revolving armatures upon the shaft, C, there will be provided three stationary magnet standards, A, and so on.

To keep the hollow magnets cool, the stationary disc is perforated at the back of the magnets, and a blast or current of air from a fan can be directed by tubes, T, into the hollows of the magnets, outlets being also provided for circulation of the air through the same.

The governor, which cuts the circuit when the machine ceases working, is shown in figs. 1 and 4. tact with the disc above. Again, when the armature revolves at too high a speed, the mercury is thrown upward with great violence against the contact disc and becomes scattered in more or less minute particles all over the machine and floor, and sometimes bath. In a gilding or plating-room the diffusion of myriads of mercury globules would do incalculable mischief in coming in contact with the work, independent of loss of mercury and irregularity of working. Another defect in the revolving cup is, that the stationary pin to which the contact disc is attached frequently becomes loosened by

Fig. 4.

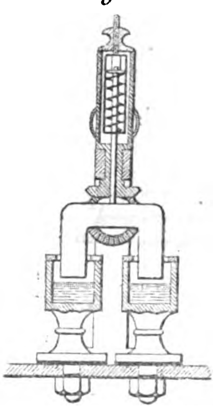


Fig. 3.

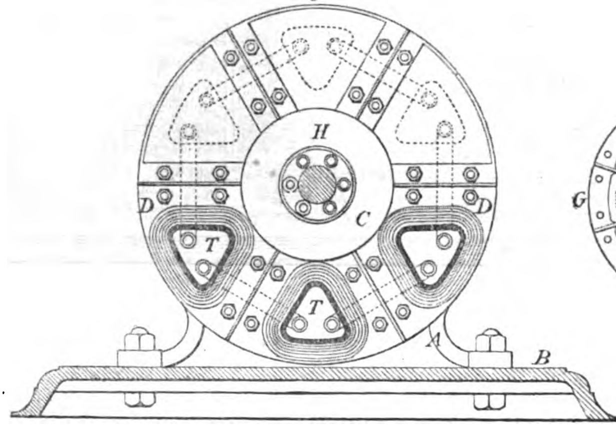
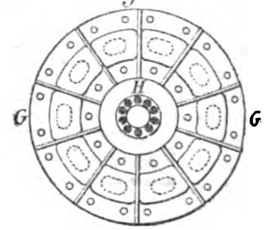


Fig. 5.



In this arrangement, contact will only be made by the saddle-shaped plunger upon the machine attaining the required speed, and so depressing and immersing the extremities of plunger arms one into each cup of mercury. The mercury is covered with glycerine, and ends of the plunger arms which dip into the mercury are platinised to prevent oxidation and to ensure perfect contact. A flexible cover of thin rubber cloth, secured by a ring, keeps out dust and dirt from the cups. In Weston's machine, even when the speed is very low, the mercury is thrown up in a spiral column, thereby making con- the vibration of the machine, causing it to slip down and make permanent contact with the mercury, or with the mercury cup itself, the governor ceasing to act. Another point of objection is, that the rapid motion of the mercury within the cup and the constant friction to which it is subject when the machine is in motion, causes the mercury to become oxidised even when glycerine is employed to prevent it. It is not an uncommon circumstance to find as much as a dessert spoonful of oxide and mercury in a finely divided state in the cup after it has been freely used.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

VI.

RELAYS (*continued*).

A GENERAL view of the *Standard* Relay is shown by fig. 30, the cover being removed and placed by the side of the instrument.

Siemens' Relay.

This form of relay is used to a greater extent than any other kind, and its general construction is very generally known. A top view of the instrument is shown by fig. 31. It consists of an ordinary electro-magnet, the poles of which are provided with soft iron shoes, or pole pieces, A, A¹. A permanent curved steel magnet, one end of which is seen at M, has its other pole attached to the centre of the bottom cross piece of the electro-magnet, thus inducing similar polarity in the pole pieces, A, A¹. The soft iron tongue, t^1, is pivotted in a recess in the end, M, of the permanent magnet; this pivotting is done in a similar way to that in the *Standard* Relay, that is to say, the end of the lower pivot rests upon a piece of hardened and burnished steel, or upon a jewel, thus perfect freedom of lateral movement is ensured, which is very important. The upper pivot turns in the bridge, *b*. The soft iron portion, t^1, is prolonged by means of an electrum tongue, *t*, at the end of which is the platinum contact, *c*. In its normal position the end of the tongue rests against the fixed screw piece, s_1, which has a piece of agate let into it, which insulates the tongue from s_1.

A small spiral of wire, *z*, ensures continuity being

preserved between the tongue and the frame of the instrument.

The brass frame piece into which the screws, S_1 and S_2, are secured, is prolonged beneath the plate, P P, the end of the prolongation being hinged; a spring draws the whole piece to the left, and the adjusting screw, S, can move it to the right, so that by a similar action to the adjustment in the *Standard* Relay the screws, S_1 and S_2, can be moved to the left or right as required. The slot in the brass-plate, P P, in which the piece holding S_1 and S_2 slides, is faced round with ebonite, so that S_1 and S_2 are insulated from the frame of the instrument.

Like the *Standard* Relay, the Siemens' instrument is wound differentially to a resistance of 200 ohms each coil, or 400 ohms in all. To obtain good signals on the Relay a current through either of the coils equal to 2½ milliwebers is required.

Although the Siemens' Relay, as ordinarily constructed, is a good form of instrument, and works well, yet in some respects it is of faulty design and construction. The moving armature is very heavy, and its whole weight drags on the top pivot of its axle, thus causing considerable friction. The flat, thin form given to the whole armature causes it to be springy. Rigidity in the tongue of a relay, although it may be difficult to understand why it is the case, makes a very considerable difference in its working qualities, indeed for some purposes a springy armature is fatal to good working. Heavi-

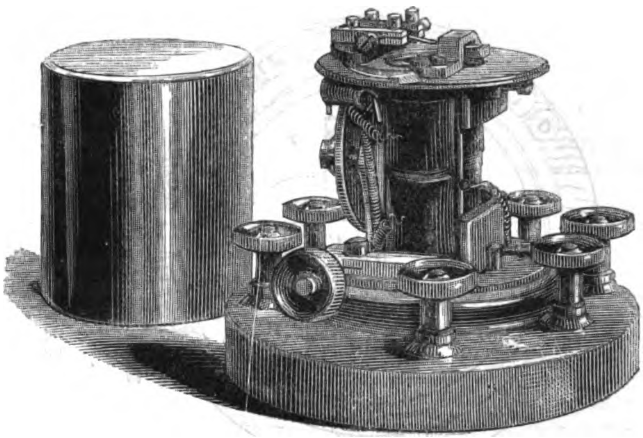


FIG. 32.

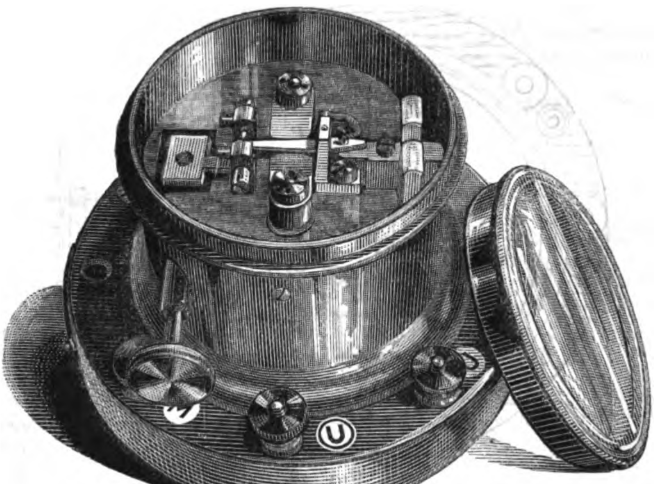


FIG. 33.

ness, from the inertia of the mass, is also fatal to rapid working, and a badly-balanced armature is also prejudicial.

To get rid of these bad qualities a large number of the Siemens' Relays are now being converted, and with excellent effect.

The Improved Siemens' Relay.

Figs. 32 and 33 show in general plan and perspective the altered form of Siemens' Relay. The smaller than the old form of armature seen in fig. 31.

The old bridge piece, *b* (fig. 31), is removed, and another bridge planted more forward in the position shown. A soft iron piece, *i*, is screwed down to the brass plate, P P, one end fitting between the slot in the magnet, M, which contained the axis of the old armature; the other end of *i* is in close proximity to the back of the soft iron tongue, t', so as to polarise the latter. The old contact screws,

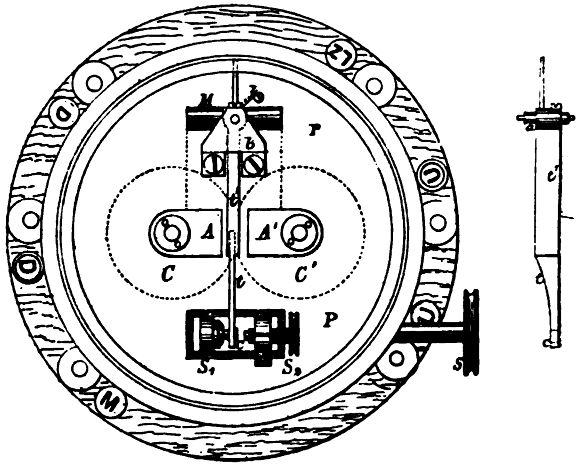


FIG. 31.

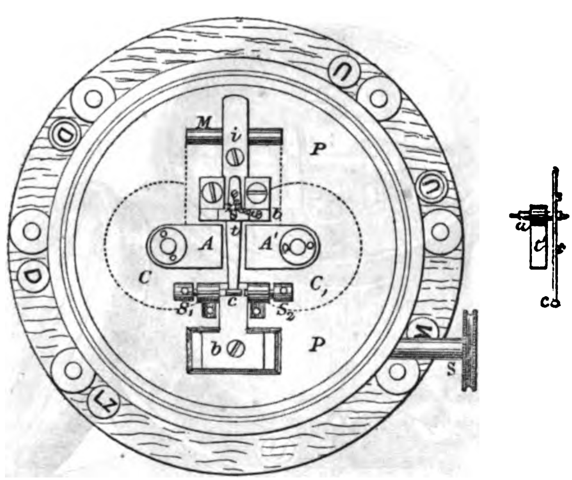


FIG. 32.

alterations are not great, and, moreover, are very easily effected at a small expense. Referring to the right hand figure of fig. 32, it will be seen that the armature consists of a short soft iron tongue, t', similar to those in the *Standard* Relay; this tongue is fixed on a short steel axle, with pivots similar to those in the ordinary Siemens' Relay; a thin tongue, *t*, with a contact platinum piece, *c*, is also fixed to the axle. The whole, in fact, forms a very light and rigid armature, being considerably s_1, s_2, are removed, and the piece into which they screw is cut down, and a new piece, *b*, provided with screws, s_1, s_2 (the former of which is tipped with ivory) is screwed to the same, so that the adjusting screw, S, can regulate s_1 and s_2 in the ordinary way. By having s_1 and s_2 brought near the centre of the instrument, the tongue, *t*, can be made short as shown. Experiments showed that a long tongue considerably diminished the sensitiveness of the arrangement. The reason of this is, tha

there is a tendency for the contact points to stick together, either from natural cohesion or from the local current slightly fusing the points together; with a long tongue the leverage exerted at the contact points by the short soft iron tongue, *t*, is considerably less than is the case with a short tongue. There is, however, a limit to the brevity of the tongue, *t*, for if it is made too short the movement of the soft iron tongue, *t'*, necessary to fairly make and break contact, becomes comparatively great, and thus the latter is thrown at each movement closer to one or other of the soft iron pole pieces, A_1 A^1, than would be the case with a less amount of play; this causes sticking, from the inability of a weak current to overcome the natural pull of the pole piece upon the tongue when the latter is near it. The relative proportions adapted, and shown in the fig., are found to give the best effect. The result of the alterations is such that the Relay will work well with 1 milliweber of current instead of requiring 2½ milliwebers, as was the case before conversion. The advantages of this increase in the sensitiveness of the instrument is obvious.

In the altered instrument the pole pieces, A_1 A^1, do not require adjustment should the working current be very strong or very weak. This was not the case with the old form.

The connections to the terminals in the altered instrument have been rearranged, as shown, so as to make them correspond in relative position with those in the *Standard* Relay.

The general appearance of the Relay will be seen from fig. 33.

ON THE INFLUENCE OF ELECTRIC LIGHT UPON VEGETATION, AND ON CERTAIN PHYSICAL PRINCIPLES INVOLVED.*

By C. WILLIAM SIEMENS, D.C.L., F.R.S.

ABOUT two years ago I mentioned to Sir Joseph Hooker, then President of the Royal Society, that I thought the electric arc might be found sufficiently powerful to promote vegetation, and that I should be willing to undertake some experiments on the subject if he could give me any hope of confirmative results. Sir Joseph Hooker gave me sufficient encouragement to induce me to follow up the subject, and I have since that time gradually matured a plan for conducting the experiment. Operations were commenced only at the beginning of the year, and although the results are necessarily incomplete, they are nevertheless sufficiently positive and remarkable to make them perhaps acceptable to the Royal Society as a preliminary communication on the subject. I was induced to look for interesting results in these experiments on account of the great abundance of blue and actinic rays in the electric arc, upon which its value in photography depends. In experimenting with powerful electric lamps for illuminating purposes, I have been struck moreover by the action produced upon the skin, which is blistered, without the sensation of excessive heat at the time, an effect analogous to that produced by solar rays in a clear atmosphere.

* Proceedings of the Royal Society.

Effect of Radiant Energy on Plants.

The apparatus which has been put up at Sherwood consists—1. Of a vertical Siemens dynamo-machine, weighing 50 kilos., with a wire resistance of 0·717 unit on the electro-magnets. This machine makes 1,000 revolutions a minute, it takes 2 horse-power to drive it, and develops a current of 25 to 27 webers of an electromotive force of 70 volts. 2. A regulator or lamp, constructed for continuous currents, with two carbon electrodes of 12 millims. and 10 millims. diameter respectively. The light produced is equal to 1,400 candles measured photometrically. 3. A motor, which at present is a 3 horse-power Otto gas-engine, but which it is intended to supersede by a turbine to be worked by a natural supply of water, at a distance of about half a mile from the house.

Experiments on Effect of Electric Light on Plants.

My object in making these experiments was to ascertain whether electric light exercised any decided effect upon the growth of plants. For this purpose I placed the regulator in a lamp with a metallic reflector, in the open air, about 2 metres above the glass of a sunk melon house. A considerable number of pots were provided, sown and planted with quick-growing seeds and plants, such as mustard, carrots, swedes, beans, cucumbers, and melons. The plants could then be brought at suitable intervals under the influence of daylight and electric light, without moving them, both falling upon them approximately at the same angle. The pots were divided into four groups.

1. One pot of each group was kept entirely in the dark.
2. One was exposed to the influence of the electric light only.
3. One was exposed to the influence of daylight only.
4. One was exposed successively to both day and electric light.

The electric light was supplied for six hours, from 5 to 11 each evening, all the plants being left in darkness during the remainder of the night.

In all cases the differences of effect were unmistakable. The plants kept in the dark were pale yellow, thin in the stalk, and soon died. Those exposed to electric light only showed a light-green leaf, and had sufficient vigour to survive. Those exposed to daylight only were of a darker green and greater vigour. Those exposed to both sources of light showed a decided superiority in vigour over all the others, and the green of the leaf was of a dark rich hue.

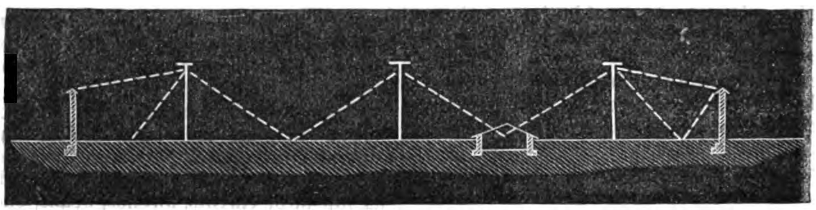
The preliminary trials proved that electric light can be utilised in aid of solar light by placing it over greenhouses, but the loss of effect in such cases must be considerable. I, therefore, directed my observations, in the next place, to the effect of electric light upon plants, when both were placed in the same apartment. A section of the melon house, already referred to (7' 3" × 3' 3", 2·21 m. × 0·19 m.), was completely darkened by being covered in with thick

matting, and was whitewashed inside. The electric light was placed over the entrance door, and shelves were put down, in a horse-shoe form, to receive the pots containing the plants to be exposed to the action of electric light, the plants being placed at distances from the lamp varying from 0·5 metre to 2 metres. Upon the first occasion of trying the naked electric light in this manner, some of the plants, and especially some melon and cucumber plants, from 20 centims. to 40 centims. in height, which were within a metre distance from the lamp, commenced to suffer; those leaves which were directly opposite the light turning up at the edges and presenting a scorched appearance. On subsequent nights, therefore, the stands were so arranged that the distance of the plants from the light varied from 1·5 metres to 2·3 metres. The plants under experiment were divided into three groups; one group was exposed to daylight alone, a second similar group was exposed to electric light during eleven hours of the night, and were kept in the dark chamber during the day time, and the third similar group was exposed to eleven hours' day and eleven hours' electric light. These experiments were continued during four days and nights consecutively, and the results observed are of a very striking and decisive character, as regards the behaviour of such quick-growing plants as mustard, carrots, &c.

A pot of tulip buds was placed in this electric stove and the flowers were observed to open completely after two hours' exposure.

One object I had in view in this experiment, was to observe whether the carbonic acid and nitrogenous compounds produced within the electric arc exercised any deleterious action upon the plants. All continuous access of air into the stove was closed, and in order to prevent excessive accumulation of heat, the stove pipes were thickly covered with matting and wet leaves. But although the access of stove heat was thus virtually stopped, the temperature of the house was maintained throughout the night at 72° F., proving that the electric lamp furnished not only a supply of effective light, but of stove heat also. No hurtful effect was moreover observed on the plants from the want of ventilation.

The next step in the course of these experiments was to remove the electric lamp into a palm house, constructed of framed glass, which was 28 ft. 3 in. long, 14 ft. 6 in. wide, and averaging 14 ft. 6 in. (8·62 m. × 14·42 m. × 4·42) in height. In the centre of this house a banana palm, and a few other small palm trees are planted, the sides of the house all round being occupied with a considerable variety of flowering plants. The electric light was fixed as high as practicable at the south corner of the house, in order that its rays might fall upon the plants from a direction and at an angle coincident with those of the sun during the middle of the day. A metal reflector was placed behind the lamp, in order to utilise the electric rays as much as possible. Along the eastern side of the house are some young vines, having their roots in a bed outside. Three pots of nectarine plants, just beginning to bud, were placed on the floor at various distances from the electric light, and also some rose plants, geraniums, orchids, &c. The temperature of the house was maintained at 65° F., and the electric lamp was kept alight from 5 p.m. to 6 a.m., for one week, from February 18th to February 24th, excepting Sunday night. The time was hardly sufficient to produce very striking effects, but all the plants continued to present a healthy appearance. Of three Alicante vines, the one nearest the electric light made most progress, and the same could be said of the nectarines and roses. It was observed that other plants, such as geraniums, continued to exhibit a vigorous appearance, notwithstanding the heat of the place. The electric light appeared to impart the vitality necessary to prevent a collapse of the organism through excessive temperature. This experiment is of importance in showing that the electric light, if put into conservatories or greenhouses, does not injure the plants, but rather improves their appearance and growth. The leaves assume a darker and more vigorous appearance, and it seems that the colouring of the flowers becomes more vivid, but a further period of time is necessary to establish this observation absolutely. Although the amount of heat given off from the electric arc is not great compared with a gas flame (giving off its products of combustion), yet the rays of intense heat of the arc counteract that loss of heat by radiation from the leaves into space, which during a clear night causes hoar frost. For this reason I expect that electric light may be usefully employed in front of fruit walls, in orchards, and in kitchen gardens, to save the fruit-bud at the time of setting; and in this application electric light will probably be found a useful agent, not only to promote rapid growth, but to insure a better yield of fruit.



Estimated Cost of Electro-Horticulture.

The experiments before given show that the most effective height at which to place the naked electric light of 1,400 candle-power is about 2 metres. By providing a metallic reflector, and thus throwing the major portion of the upward rays down upon the surface to be illuminated that height

may be taken at 3 metres. If the electric arc employed was equal to 6,000 candles, the height would be $\frac{\sqrt{6,000}}{\sqrt{1,400}} \times 3 = 6{\cdot}2$ metres, at which height an electric light should be fixed under the protection of a tin plate or other reflector. In operating upon an extended surface several lamps should be placed at such distances apart as to make the effect over it tolerably uniform. The effect of radiation would be equally distributed over the ground if the radiating centres were placed at distances apart equal to double their height above the ground; for under these circumstances a square foot of surface midway between them would receive from each centre one-half the number of rays falling upon such a surface immediately below a centre. A plant at the intermediate point would, however, have the advantage of presenting a larger leaf surface to the two sources of light; and in order to compensate for this advantage, the light centres may be placed considerably further apart, say at distances equal to three times their elevation, or 18 metres. Nine lights so placed would cover an area 54 metres square, or just about $\frac{3}{4}$ acre. If this space was enclosed with a high fruit-wall (as shown with the lamp centres marked in the accompanying sketch), this will also get the full benefit of electric radiation and would serve at the same time to protect the plants from winds. Protection against injury from this latter cause might be further carried out with advantage by the following plan adopted (with excellent results I believe) by Sir William Armstrong, that of subdividing the area under forced cultivation by vertical partitions of glass.

The engine-power necessary to maintain this radiant action would be $9 \times 4 = 36$ horse-power, involving the consumption of $36 \times 2\frac{1}{2} = 90$ lbs. of fuel per hour, or say, for a night of 12 hours (with an allowance of 40 lbs. for getting up steam) 10 cwt., which, at sixteen shillings per ton, would cost eight shillings. This expenditure would not include, however, the cost of carbons and of an attendant, which would probably amount to another eight shillings, making a total of sixteen shillings. If, however, an engine can be found doing other descriptions of work during the day time, the cost of steam-power and attendance for the night-work only would be considerably reduced. In the calculation just given, I have assumed the employment of fuel for the production of mechanical energy, whereas the question will assume a totally different aspect if natural sources of power, such as waterfalls, can be made available within the reasonable distance of half a mile. The expenditure for energy will, in that case, be almost entirely saved, and that of attendance be greatly diminished, and under such circumstances it seems probable that electro-horticulture may be carried out with considerable advantage.

The experiments furnish proof that the management of the electrical apparatus presents no particular difficulty, as the gas-engine, dynamo-machine, and regulator have been under the sole management of my head gardener, Mr. D. Buchanan, and his son an assistant gardener. The regulator requires no attention beyond the replacement of carbons every four or five hours, which period may easily be increased to twelve hours, by a slight modification of the lamp.

Notes.

A SYSTEM of pneumatic clocks has recently been inaugurated in Paris, the motive power is obtained from a steam-engine which compresses air and distributes it every minute through a pipe with which the clocks are in communication, thus at every minute the hands of all the clocks in connection with the tube are moved forward a corresponding distance. The employment of a steam-engine in the place of a small battery, and the employment of a tube in the place of a small wire, does not seem to be a very progressive improvement.

ALTHOUGH as regards clocks, pneumatic power in Paris seems to be in the ascendant, yet *La Lumière Electrique* announces that it is in contemplation in Paris to transmit message forms bodily by electricity instead of by pneumatic power as at present. To this end small engines driven by electricity are employed, the whole forming a miniature railway. The system has been tried, and it is stated that the small engines will run with a load of 14 lbs. at the rate of 15 miles an hour.

SINCE the paper on "Influence of Electric Light on Vegetation" was read, Dr. Siemens has written a letter to the editor of the *Gardener's Chronicle*, in which he says, that "The strawberries exposed to the electric light have made extraordinary progress, and I shall exhibit before the Royal Society to-morrow night two pots that were exactly alike a fortnight ago, the one which was exposed to the electric light having now ripe fruit, while the other, which was exposed to solar light only, but kept at the same temperature, has, as yet, only unripe green fruit. At the Royal Society to-morrow you will have an opportunity of tasting the fruit, to ascertain whether the electric light produces aroma or not. It is also interesting to observe some melon plants, which did remarkably well under the night influence of the electric light, but which have produced fewer leaves since the light has been shifted to another point for the strawberries. Regarding the question of cost, I find that the power cost me 67 cubic feet of gas per hour, say 4s. per hour, or, including attendance, 6s. per hour for a light of 1,400 candle-power. Greater powers than this would be relatively cheaper."

MR. W. CHEW, of Blackpool, recently read a paper before the Manchester District Institution of Gas Engineers, entitled, "Three Months' Experience of Electric Lighting at Blackpool." In it he gives the capital expenditure for electric light at Blackpool, Westgate, and Thames Embankment, respectively, as:

Blackpool (six lights=36,000 candles available)...	£2,800
Westgate (six lights=1,182 candles available ...	1,100
Thames Embankment (twenty lights=4,000 candles available ...	2,000

Also, he compares the working expenses now at Blackpool with the others, for one night of $5\frac{1}{2}$ hours, thus:

	£	s.	d.
Blackpool, 36,000 candles ...	£3	6	10
Westgate, 1,182 ...	1	16	10
Thames Embankment, 4,000 ...	3	8	8

DR. SIEMENS ON THE APPLICATIONS OF THE DYNAMO-ELECTRIC MACHINE.—The Friday evening lecture on March 12th was delivered by Dr. C. W. Siemens, the subject being "The Applications of the Dynamo-Electric Machine." Faraday's discovery in 1831 of magneto-electric induction was first referred

to, the identical apparatus from which the first magneto-electric spark was obtained being exhibited and experimented on. The discovery of Faraday was the result of several years of laborious thought, and was not a mere accidental discovery. The apparatus with which Faraday experimented, although it demonstrated the principle of magneto-electric induction, only produced feeble effects, and it was not until the invention of the armature of Dr. Werner Siemens, which bears the latter gentleman's name, that powerful magnetic currents could be produced; the invention of the Siemens armature was made in 1854. This form of armature was utilised by Professor Holmes in his powerful magneto-machine, and subsequently by Wilde of Manchester. In 1867 the accumulation or reaction principle was announced to the Royal Society simultaneously by the author and Sir Charles Wheatstone. This principle is the foundation of the dynamo-electric machine. Dr. Siemens stated that so far as he himself was concerned he considered that the merit of the discovery belonged to his brother, Dr. Werner Siemens of Berlin. The power of the dynamo-machine was illustrated by its power to fuse a wire and to turn a fan, the machine being driven by hand. With a more powerful machine a circular saw was turned, thus illustrating the principle of the transmission of power. The electrical railway was then alluded to. The electric light, Dr. Siemens stated, could be furnished in the simplest manner by the incandescent system, but this could never excel the arc in economy. The great heating power of the arc was such that it had been applied to the fusion of metals in a crucible. In this arrangement one electrode was placed through the bottom of the crucible and the other electrode was attached to a solenoid regulator, which kept the length of the arc between the two carbons regular. Pieces of steel placed in the crucible were fused in about twenty minutes, which was much quicker than would be the case in an ordinary blast furnace. The application of the electric light to horticulture was also alluded to and explained.

The magistrates of the city of Berlin have appointed a special commission of engineers and architects to examine into and report upon the scheme for the construction of an electric railway across a portion of the capital submitted by Messrs. Siemens and Halske. The line would start from the Belle Alliance Place, and run through Friedrich and Chaussée Streets on to the Wedding Place. There will be two lines of rails, one for the up and the other for the down journey. The viaduct will be carried on iron pillars 14ft. 9in. high, and nearly 33ft. apart. These pillars will be placed along the edge of the footpath, so as to cause the least possible interference with the ordinary traffic. The carriages will be narrow and short, containing ten sitting-places and four standing-places. The electro-dynamic machine which will propel the carriages will be placed under the floor of the carriage between the wheels, and a steam-engine of 60-horse power, which will be employed in the production of the electricity, will be placed at the terminus. The stoppages will be very few, and the rate of speed will be, it is expected, about twenty miles an hour. The chief object of the undertaking is to convey persons quickly across the city, and especially to facilitate access to the city line of railway. The chief objection raised is that the carriages will pass along at the level of the first floor of the houses in the streets which it will traverse, and it is feared this will lead to a depreciation of property.

Extraordinary.—From the 2nd of March to the 25th of March no patent was filed at the British Patent Office under the head of "Electric Light."

J. Violle, in *Comptes Rendus*, states that the specific heat of iridium, which has been determined up to a temperature of 1,400°, is found to increase regularly with the temperature according to the formula $C_0 = 0{\cdot}037 + 0{\cdot}000006t$. The melting point determined by the calorimetric method is found to be 1950°. The melting points of the different metals determined by the author are—silver, 954°; gold, 1,035°; copper, 1,054°; palladium, 1,500°; platinum, 1,775°; iridium, 1,950°.

Telephonic communication has been established between the meteorological station of the Pic du Midi and Bagnères-de-Bigorre, a distance of 30 kilometres. The Edison telephone is the instrument employed.

The telephone line erected in the Cape Colony between Kimberley and Du Ports Pan has been purchased by the government.

A new diving helmet, with telephone attached, belonging to the Telephone Company, Limited, was tested last Thursday afternoon at Earl Grey Dock, Dundee. The helmet was fitted on Fox, the diver, who descended into the water, and the practicability of the instrument was fully shown by the easy communication which was kept up between the diver and the gentlemen on the quay. A large number of gentlemen were present during the trials, which proved very satisfactory.

Dr. Oliver J. Lodge, in a letter to the *Philosophical Magazine*, thus speaks of Professor Hughes' Induction Balance (described on p. 179, vol. VII, T. J.):—"Soon after hearing of Professor Hughes' discovery, I tried to obtain his effects with numerous coils which happened to be accessible in University College Laboratory, varying the conditions in several ways; and I experienced the most uniform failure in getting a good 'balance' (that is, perfect silence in the telephone) until I abandoned all of them and imitated Professor Hughes' arrangement and dimensions very closely. A 'balance' in fact is a very difficult thing to obtain with such a detector in the circuit as a telephone, for it is influenced not only by the least want of equality, but also by the least want of synchronism between the two opposing electromotive forces. Few persons therefore can appreciate more highly than I do the unremitting toil which Professor Hughes must have devoted to his experiments, before contriving the induction balance and sonometer in their present form."

By the employment of a hard rubber membrane and a microphone attached to it, and by regulating the pressure of the latter against its contacts, by means of a permanent magnet acting on a piece of iron attached to the movable carbon, Mr. Paul Bert obtains a microphonic transmitter which is free from the disagreeable crackling noises so often perceived in microphonic transmitters of ordinary construction, and which transmits speech with great clearness.

A telegraph war of large proportions has been commenced in the United States, the new American Union Telegraph Company and its supporters being the assailants, and the Western Union the attacked party. The first move was the seizure, without notice, by the Baltimore and Ohio of all the wires over its lines, which had been worked by the Atlantic and Pacific Company, and in close conjunction with the Western Union. This was followed by the seizure of the wires over the Union and Kansas Pacific lines, the company taking possession and notifying the Western Union to remove certain wires owned by it. All the

seized wires were turned over to the American Union, or at least placed at its disposal. The Western Union was taken by surprise at first, but acted as promptly as possible. A temporary injunction was obtained in time to save its wires on the Missouri Pacific and Central Branch Roads. The fight has since extended to the communications in Eastern cities, and one of the latest incidents reported is a citation served on President Garrett, of the Baltimore and Ohio Company, for contempt of court. It is needless to say that Jay Gould is the originator of the hostilities.—*Railway News.*

AN AMERICAN ELECTRICAL PATENT.—A somewhat curious Patent suit has lately come before the United Sates Circuit Court. The history of this case is briefly as follows:—Many years ago, dating back to 1836, it is said, Charles Grafton Page, of Washington, D.C., first made electrical inventions, among which, it is alleged, was an electrical coil and armature, which had a set screw applied to adjust or regulate the throw or motion of the armature. Without this little set screw, or its mechanical equivalent, it would be practically impossible to work an ordinary telegraph instrument, signal apparatus, burglar alarm, or electric motor. Page suffered his invention to go into public use without taking steps to apply for a patent, and under the general patent laws, in consequence of his neglect, lost all right to a patent. But in 1854 it appears to have occurred to him that perhaps at some future time or another he might coax Congress to grant a special act in his favour, and as preliminary thereto he filed an application for a patent, which under the law was refused examination, on the ground that the invention was public property, and he himself was an examiner in the Patent Office. Page was, in fact, the examiner of electrical patents, and for many years it had been his official duty to issue hundreds of patents, all of which contained his alleged original invention. In 1868 Page was taken sick, and when it appeared that he had not long to live, Congress, at the instance of his friends, with a view to assist his family, passed the following unwise and sweeping act:—

"Chap. XXXII.—An act to authorise Charles Grafton Page to apply for and receive a patent:—Be it enacted by the Senate and House of Representatives of America, in Congress assembled, that the Commissioner of Patents is hereby authorised to receive and entertain a renewal of the application of Charles Grafton Page for letters patent for his 'induction apparatus and circuit-breakers,' now on file in the United States Patent Office, including therewith his circuit-breakers described by him prior to said application; and that if the Commissioner shall adjudge the said Page to have been the first inventor thereof, he *shall issue* to him a patent, *which patent shall be valid* notwithstanding said Page's invention may have been described or in use prior to said application, and notwithstanding the fact that said Page is now an examiner in the United States Patent Office; *provided* that any person in possession of said apparatus prior to the date of said patent shall possess the right to use, and vend to others to use, the said specific apparatus in his possession, without liability to the inventor, patentee, or any other person interested in said invention or patent therefor.—Approved March 19th, 1868."

On the passage of this act the Commissioner of Patents, in accordance with the mandates of the special law, caused the examination to be made, and then ordered the issue of a patent, which was dated April 14th, 1868. Dr. Page died May 5th, 1868.

It was pretty generally doubted at the time of the passage of the law and the grant of the patent, whether the latter could ever be sustained in the courts, and among the greatest doubters were members of the Western Union Telegraph Company. However, as as there would be a possibility of litigation against them in any event by the holders of the Page patent, they concluded that the safest way was to purchase an interest in the patent enough for their own protection, and for a small sum they acquired such interest from the heirs of Mr. Page. Subsequently, it appears, the Western Union Company acquired the substantial control of the patent, and in 1874, after careful preparation, brought this suit against the Holmes Burglar Alarm Company as a test suit.

Judge Blatchford's decision, we understand, sustains all the points made by the plaintiffs. It was urged in the case that the Special Act of Congress, in 1868, was unconstitutional, as the apparatus had been in use so long, but the decision is that the Special Act was constitutional. The validity of the entire patent was affirmed, the claims specifically sustained in the decision being the eleventh, twelfth, and thirteenth, and here is where the great importance of the case appears. These three claims are:—

11. The adjustment of the retractile force of an automatic circuit breaker, as set forth.

12. The combination of an electro-magnet armature and adjustable retractor.

13. Adjusting or regulating the length of vibration of the armature of an electro-magnet by means of a set screw or any mechanical equivalent for substantially the same purpose, substantially as herein set forth.

We intend in a future number to discuss the subject further and present abstracts from the judge's decision, which, we are informed, covers fifty pages, and is a very formidable and exhaustive document.—*Scientific American.*

PONCI'S GALVANIC BATTERY.—A new galvanic battery with circulating liquid, described by Signor Ponci in *Natura* (3, p. 402, 1879), has the following form:—Rectangular lead channels, beak-shaped at one end, are so placed over one another in slanting position that the beak of the first is over the broad end of the second, and so on. In each channel is an amalgamated zinc plate, and above this a carbon plate insulated from it by two rings of caoutchouc; the carbon plate is perforated under the beak of the lead channel above. The lead channels have wires, and the carbon plates, at their upper ends, binding screws, with which they are alternately connected. By means of a caoutchouc syphon a solution of chromate of potash is conducted through the system—200 gr. $K_2Cr_2O_7$, 21 water, 11 commercial muriatic acid; for long use, 3 to 6 litres water and 100 to 150 ccm. muriatic acid may be added to each litre of the solution. A battery of 99 such elements gives a light equal to that of a battery of 60 Bunsens, and is constant in duration.—*Nature.*

Reviews.

A Guide for the Electric testing of Telegraph Cables. By CAPTAIN V. HOSKIÆR. Second Edition. 1879. E. & F. N. Spon.

THE fact that a second edition has been called for speaks well for the utility of this unpretending little work. Some twenty additional pages have been added on in the new edition, making a handy little volume of seventy-two pages, containing much useful information. For those who wish for a book of reference which tells what tests are necessary for

a cable, both during and after its manufacture, the book in question is exactly the article required, although it does not, except in one or two cases, enter into any explanation of the theory upon which the tests are based, or to explain how the various formulæ used are obtained. Information of the latter kind must be sought for elsewhere, as for instance in Mr. Kempe's "Handbook of Electrical Testing," but the absence of such information in Captain Hoskiœr's work cannot be regarded as a defect.

Kriegs-Telegraphie. Geschichtliche Entwickelung, Wirkungskreis und Organisation Derselben. By R. VON FISCHER-TREUENFELD. 1879. Stuttgart von W. Kitzinger.

As far as we are aware this book is the first attempt to give a detailed description of military telegraphy. This branch of telegraphic science is by no means new, in fact, as is well known, it was for war purposes that telegraphy was used from the earliest ages. The use of the electric telegraph for field operations is by no means of quite recent date. During the Crimean war a field electric telegraph train, well equipped, was used with considerable advantage by the British army; since that period, although much has been done in the subject, but little has been written on it, possibly because it was policy to keep the matter dark, or at least not to volunteer descriptions of the matériel employed, and of the organisations of the services. Mr. Treuenfeld's work has now enabled this ignorance to be put an end to, to a great extent, and those who wish for information on the subject cannot do better than study his book, where, in a volume of nearly four hundred pages, a very full description is given of the organisations of the military telegraph systems in every part of the world. The book is divided into three parts, the first describing the use that has been made of the telegraph in various campaigns in different parts of the world; the second portion relates to the apparatus and equipments used, and the arrangement of the signalling stations, &c.; and the third part deals with the organisations of the service in the various armies. In many respects the matériel employed for war purposes differs from that used for public purposes, chiefly in the matter of portability, ease of transit being a most important consideration.

Whilst recommending Mr. Treuenfeld's work to those who desire information on the subject, we think its value would be greatly enhanced if an English translation were prepared, as it is not every one who is interested in military telegraphy that has such a command of the German language as will enable him to read and profit by the Kriegs-Telegraphie.

Proceedings of Societies.

PHYSICAL SOCIETY.—MARCH 14th.

DR. HUGGINS in the chair.

New members—Prof. MINCHIN, Mr. HULME, Mr. A. STROH, Prof. D. E. HUGHES, Lieut. WINGFIELD, Mr. MACFARLANE GRAY.

Mr. CHANDLER ROBERTS, F.R.S., drew attention to an explanation which had recently been suggested by Dr. Van Riemsdijk, of Utrecht, to account for the "flashing" which attends the solidification of melted buttons of gold and silver. He showed experimentally that at the point of solidification the metals emit a flash of greenish light, which Dr. Riemsdijk thinks is probably due to the globules being really in what is known as the superfused or surfused state—that is, they fall some degrees below their point of solidification without setting, and the change from the liquid state is accompanied by the liberation of the latent heat effusion which again heats the globule and renders it incandescent. In an attempt to obtain indications as to the state of certain fused metals by the aid of the induction balance, Mr. Roberts was able to show that the resistance of silver in the molten state is far greater than when the metal is solid; and on the other hand, he had confirmed De Lakine's statement, that the resistance of molten bismuth is less than that of the solid metal, and he also obtained evidence that bismuth in cooling may be made to pass through a surfused state similar to that which occurs in the buttons of gold.

Mr. N. LOCKYER thought the greenish tint of the light might be due to a solid film on the globule.

The SECRETARY then read a paper by Prof. W. F. Barrett, announcing that he had found a current of electricity to be generated by the rotation of the prepared chalk cylinder in the receiver of the Edison telephone. When the platinum stylus, which rubs on the cylinder, is connected through a galvanometer to the brass axle on which the cylinder is mounted, a current is observed whose E.M.F. is over ¼ volt. This current falls off as the rotation continues, owing, Prof. Barrett surmises, to the electrification of the surface of the chalk. Prof. Barrett attributes the current to friction solely, and seeks to account for the receiving action of Edison's telephone by this frictional current being modified by the transmitted currents, and not by the electrolytic action to which it is usually ascribed. These experiments originated with a suggestion of Prof. Sylvanus Thompson, that the Edison receiver might act as a transmitter. Prof. Barrett had at length succeeded in making it act in this capacity by means of the frictional current.

Mr. SHELFORD BIDWELL exhibited some experiments bearing on Prof. Barrett's observations, which tended to show that the source of the current in the Edison receiver was due to the fact that a voltaic element is formed by the platinum-rubbing point on the brass axle and the prepared chalk. This chalk is usually impregnated with phosphate of soda, or, as in the author's experiments, with caustic, caustic potash, and acetate of mercury. The cylinder seems to be dry, but is probably moist. Melting it greatly increases the current. There is a very feeble current when no motion of the cylinder takes place, but rotation of the cylinder greatly increases it. Platinum is electro-negative to brass, and hence the positive current flows from the platinum to the brass through the galvanometer. This was demonstrated by substituting zinc for platinum, when the current was reversed, and flowed from the brass to the zinc, owing to the fact that brass is electro-negative to zinc. Mr. Bidwell showed, by means of a simple pile of copper and tin-foil, separated by a moist cloth or paper, that the motion of the tin across the paper increased the current of the cell. In the case of a cell made of two tin plates separated by moist paper, a current was set up by moving one plate over the other. The plate which moved relatively to the paper was always electro-

negative to the other. Mr. Bidwell also showed by a simple experiment that the action of Edison's receiver was electrolytic. He caused the mere passage of a current to lessen the friction of a metal strap on a drum covered with moist paper, and thereby release the drum by the evolution of hydrogen.

Professor AYRTON pointed out that the rubbing action in these experiments assisted the current by bringing up fresh electrolytic matter, a fact which had been taken advantage of in the construction of several batteries.

Professor ADAMS remarked that this explanation did not seem to explain how the current was *reversed* in the cell composed of *two* tin-foil plates.

Professor GUTHRIE then demonstrated by experiment a curious anomaly in frictional electricity. When flannel is rubbed with ebonite the flannel is + electrified: when ebonite is rubbed with glass the ebonite is + electrified, and we should therefore expect that when flannel is rubbed with glass the flannel would be still more + electrified; but instead of that it is really feebly negative. Perhaps this fact that the heat of friction entering into one substance more than the other affected such results.

The SECRETARY then read a note from Mr. Ridaut stating that he had succeeded in Dr. Guthrie's funnel experiment mentioned at last meeting, and, by means of a stream of water flowing out of a glass funnel, had attracted a glass cone towards the mouth of the funnel. The angle of the cone was greater than the angle of the funnel.

THE SOCIETY OF TELEGRAPH ENGINEERS.

AT an ordinary general meeting of this Society, held March 24th, Mr. W. H. PREECE, President, in the chair, the minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed members having been read, the discussion on Mr. ALEXANDER SIEMENS' paper on "Recent Improvements in Electric Lighting," adjourned from the last meeting, was continued.

At the commencement of the discussion a communication from M. BERLY was read by the Secretary.

In 1877 six Jablochkoff candles were in use at the Magasin du Louvre; this number was since increased to 120, produced by means of a 100 horse-power engine. These had been worked for 2½ years without intermission and with perfect success.

In February, 1878, the Theatre Français and other buildings were illuminated by the Jablochkoff system. The Place du Grand Opéra was also lighted.

In 1878 the Metropolitan Board of Works commenced a trial of the system on the Thames Embankment, 20 lights being used; subsequently other lights were added, on Waterloo Bridge and also the Embankment to Blackfriars Bridge. The number of lights now in use was 60. Messrs. Shoolbred's establishment, in the Tottenham Court Road, was also lighted by the Jablochkoff system, 25 lights being now in use; several other establishments, Messrs. Nicolls, in Regent Street, and Messrs. Samuel Brothers, Ludgate Hill, amongst these. The Picture Gallery, or Salon, in Paris, has also been lighted by the system, 16 dynamo-batteries of 16 lamps each being employed for the purpose. The total number of candles at present in use is as follows:—465 in Paris, 428 in the provinces, and 823 in foreign countries, or 1,716 in all. In this country there are 198. The cost for a large number of candles was 3d. per hour per candle, but this has now been reduced to 2½d. per hour. The cost of the candles, which was originally 8d. each, is now reduced to 4d., the candles burning two hours each, this would be shortly increased to three hours. As regards cost per horse-power, this had been reduced from 5d. per horse-power per lamp to 2d. per horse-power per lamp. An improvement in the candles was effected by covering them with a coating of electro-type copper. A form of candle which relit itself if extinguished had been tried in the British Museum in 1879.

A system of automatic switching from one candle to another, so as to introduce a fresh one on the first being consumed, was now under consideration and trial.

As regards dynamo-machines, M. Berly referred to the Gramme Alternating Current Machine* as being an excellent apparatus.

Gas engines were largely in use for driving the dynamo-machines, and worked very successfully.

In speaking of the progress of the light, M. Berly referred to the ridiculous estimates which had been made from time to time as to the impossibility of burning a large number of lights except at an enormous expenditure of power and labour. The engine power (nominal) of the Thames Embankment lights was equal to 20, and this lighted four and a-half miles of frontage. M. Berly predicted a great future for the electric light.

Mr. MACKENZIE then explained a lamp invented by himself.

Mr. HEINRICHS gave further explanations of his lamp, and stated that it would burn for 30 hours; the unsteadiness which existed was explained to be due to defective carbons, it being difficult at present to make them sufficiently hard in the ring shape.

Mr. HEDGES next explained his lamp. This consisted of two carbons, the ends of which pressed at an angle against a block of lime which was kept continually rotating. The arc formed between the ends of the carbons, and the heat produced, rendered the lime incandescent, thus increasing the light.

Mr. H. F. JOEL then exhibited an improved form of Werdermann lamp. In this arrangement the pencil of carbon pressed against a heavy disc of copper, the latter being hinged; the weight of the disc normally relaxed the grip of a clip which held the carbon-rod, the latter being pressed upwards by means of weights. As the rod consumed, the copper disc tended to fall down, thus relaxing the clip and allowing the rod to rise. The whole arrangement of the lamp was such that the carbon-rod could be replaced with great ease when consumed. The current was turned off and on by means of a switch similar to an ordinary gas tap. When turned off the current was shunted through a resistance formed of carbon-rods. The resistance of the lamp when burning was ·16 ohms, and the average resistance when not burning was ·39 ohms. The faces of the copper clip were now formed of carbon, as it was found that a better contact was obtained by this arrangement. As regards economy, Mr. JOEL stated that by recent improvements the economy had been nearly doubled, and the principle compared favourably with the arc lights.

In reply to Professor ARYTON, Mr. JOEL stated that the resistance of the lamp was ascertained by the substitution method, that is to say, a resistance was inserted in the place of a lighted lamp, and varied until the original strength of current was obtained.

Mr. S. A. PHILLIPS then explained Mr. Brockie's new lamp, a full description of which is given on page 114 of the present number.

Mr. CONRAD COOKE summarised the progress which

* *Telegraphic Journal*, January 15th, 1880.

had been made in electric lighting, pointing out the various steps which had been made.

Mr. LADD said that the BRUSH light at the Liverpool Street Station, which had been installed under his directions, was most remarkable for its steadiness, no flickering being noticeable. He stated that the length of the arc averaged two millimetres, and if a particular lamp was observed by having the carbon points projected on a screen the steadiness of the length of the arc could be well seen; if extra lamps were added in a circuit the arc *immediately* became shortened, and if lamps were taken out the arc was immediately lengthened. The Brush dynamo-machine was remarkable for the absence of heating which took place in its coils. Eight Brush lights had been put up in the South Kensington Museum, and they were remarkable for their steadiness.

Mr. Ladd pointed out that the photometric intensity of the light was dependent upon the level at which it was measured; on a level the light was about 970 candles, but at an angle of 45° below the arc the light was quite 2,000 candles. The engine at Liverpool Street was of 14 horse-power, manufactured by Messrs. Wallace and Stevens, and ran with remarkable steadiness.

Mr. Ladd stated that it was a mistake to burn both gas and electric light, as the one spoiled the effect of the other.

Mr. CROMPTON stated that his lamps, two of which were exhibited in action before the meeting, as a rule, burnt without the slightest flicker; but, like every other lamp, it was necessary that the conditions under which it was tried should be properly arranged, which was impossible in a lecture hall, as proper adjustments could not be made in a short time. Mr. Crompton apologised for having stated that the unsteadiness of Messrs. Siemens' lamp at the previous meeting was due as much to the lamp as to the engine working irregularly. He said that a short arc produced the best effect, and that it was very necessary that the dynamo-machine should be wound to suit the work required of it.

Mr. SHOOLBRED pointed out that great improvements had been made in Messrs. Siemens' dynamo-machines. With reference to M. André's lamp he said that the water joint was a great advantage. Jamin's candle was explained, but Mr. Shoolbred stated that its advantages had not been fairly proved as yet.

As regards the general question of illumination, that is to say, of a number of gas lamps as compared with a small number of electric lamps, Mr. Shoolbred said that the question of *space* illuminated was a factor which had not been sufficiently taken into consideration.

In reply, Mr. ALEXANDER SIEMENS said that it was difficult to please every one, and that his reason for not describing every system was that he preferred to describe the one he knew most about. He very strongly protested against the practice of stating the *nominal* horse-power of an engine and not the indicated horse-power; the latter was the only true index of the work done, and the only factor upon which an estimate of cost could be based. In reply to Mr. Ladd, Mr. Siemens stated that the photometric measurements of their lamps were always made on a level with the latter; the space lighted, he agreed, was a factor to be considered, and this to a considerable extent limited the use of the electric light to very large spaces from an economical point of view. In the Albert Hall the electric light was economical for this reason. For street-lighting he did not consider electric lighting to be cheap.

In proposing a vote of thanks to Mr. Siemens, the PRESIDENT argued that it was unfair to compare electric with gas lighting, as the two had their distinct fields of usefulness. He thought there was still great room for improvement in electric lighting, but the engines for the purpose had been brought to a great state of perfection, notably the Wallace-Stevens engine. As regards the dynamo-machine opinions differed as to the relative efficiency of the various patterns, an opinion generally being in favour of the machine which any particular individual had tried. Mr. Preece also insisted upon the question of space lighted being always taken into consideration in making estimates.

The meeting then adjourned.

The next meeting will take place April 14, at which Dr. C. W. Siemens will lecture on "Applications of Dynamo-Electric Machine."

New Patents—1880.

1046. "A new or improved method for compressing air by electricity for obtaining motive power." V. POULT and E. COMMELIN. Dated March 10.

1079. "Improvement in self-acting regulators for the expansion and contraction of metallic wires used for working railway signals." G. EDWARDS. Dated March 12.

1081. "Telephonic Apparatus." E. H. W. HIGGINS. Dated March 12.

1125. "Improvements in electric railway signals and in electric safety appliances for railways and railway trains." J. C. MEWBURN. (Communicated by T. A. B. Putnam.) Dated March 16.

1136. "Magneto-electric and dynamo-electric machines." J. H. JOHNSON. (Communicated by A. de Meritens.) Dated March 16.

1151. "An improved micro-telephonic apparatus for intensifying sound during transmission." R. H. COURTENAY. Dated March 17.

1178. "A dynamo or magneto-electric machine to convert mechanical energy into electricity, or to convert electricity into mechanical energy." J. PERRY. Dated March 18.

1184. "Improvements in, and in apparatus for, insulating, containing, and protecting surface and underground telegraph wires." J. T. KING. (Communicated by C. Lindford.) Dated March 19.

1212. "Improvements in electrical fire alarms, and for giving immediate notice of the outbreak of fire from any outlying or other station to the district or chief engine station, or between each station." C. E. SPAGNOLETTI. Dated March 20.

1234. "Improvements in galvanic batteries, and in the composition, preparation, and regeneration of the materials employed therein." A. M. CLARK. (Communicated by N. E. Reynier.) Dated March 22.

1244. "Improvements in regulating electro-magnetic motors and in the apparatus employed therein." J. H. JOHNSON. (Communicated by W. W. Griscom.) Dated March 23.

1259. "Electro-magnetic motors and dynamo-electric machines. J. H. JOHNSON. (Communicated by W. W. Griscom.) Dated March 24.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

2575. "Telegraphic apparatus for railways." EDWARD TYER. Dated June 26. 6d. Relates to apparatus employed on railways for the purpose of communicating from one part of a line to another signals as to the arrival, departure, or condition of

trains, so as to guide the attendants in the working of the points and signals under their charge. Hitherto signalling instruments have been employed showing by the position of an index on a dial the character or destination of an approaching train. The object of the invention is to provide for such instruments means of securing such slowness and regularity in the transmission of the operating currents that the index shall not trip, but shall always be moved over the proper number of divisions of the dial to give the signal intended.

2821. "Automatically opening and closing electrical circuits." G. Zanni. Dated July 10. 6d. Consists of an electro-magnetic apparatus constructed and arranged in combination with the magneto-electric machine, or a battery or other generation of electricity (either connected or not connected with the said dynamo-electric machine) in such a manner that the said circuit will be closed or opened automatically whenever the dynamo-electric machine commences or ceases to work in plating processes.

2878. "Manufacture of magnetic stays, corsets," &c. W. Wilson. Dated July 15. 6d. Consists in perforating the magnets used with three or other number of holes, the object of which is to set up a local electric action when the said magnets are fastened to the fabric by eyelets of suitable mixed metals, such as brass or other alloy, &c.

2962. "Joints of pipes for containing underground telegraph wires." A. M. Clark. (A communication from L. A. Herrmann, of Paris.) Claims a spigot and socket joint for pipes with a groove to contain the lead packing. The combination of this socket with a lead packing, formed either by running in the molten metal as usual, or by "setting up" or compacting a ring of lead divided diametrically, or by winding a lead wire several times round the spigot end and setting it up or compacting it when in place.

3085. "Regulators for the electric light." B. J. B. Mills. (A communication from Francisque Million, of Cours Morand, Lyons.) Dated July 30. 6d. The carbons are carried by supports which slide vertically, and are formed with rack teeth to gear with a toothed pinion, which, according as it turns to the right or the left, causes the points of the carbon to approach or separate from each other. Upon the axis of this pinion is fixed a larger wheel, toothed around its circumference, and upon which acts a regulating instrument carried by a balance or pendulum, which is furnished with an iron armature operated by the electro-magnet traversed by the current. Two stops limit the motion of this balance or pendulum, which is drawn back by a spring in opposition to the electro-magnet. The regulating instrument is formed simply of a tooth fixed to the extremity of a spring carried by a cross-piece fixed to the balance or pendulum, and the tension of which is regulated by a screw.

3132. "Electrical communication between ships and shore." Severin Lauritzen, W. C. Johnson, and S. E. Phillips. Dated August 2. 2d. To enable a ship and the shore to communicate with each other, a telegraphic cable is laid out to sea for the required distance, and the passing vessel is provided with a short length of cable, which is trailed along the bottom of the sea. Currents of electricity are sent into the trailing cable, and when this approaches or passes over the other cable, these currents will be appreciable on shore by means of a telephone, galvanometer, or any other suitable method of appreciating electric currents, but preferably by the former. (*Provisionally only.*)

3272. "Electric lightning apparatus." W. R. Lake. (A communication from Dr. Luiji Concornotti, of Crémone.) Consists of two metallic rods and a rod of carbon. The contact between this carbon bar and the two rollers is at first only along two very narrow zones corresponding to the geometrical generating lines. During the passage of the current this contact is, so to speak, no longer absolute by reason of the repulsions of the contiguous elements of one single current. The result is that two very small voltaic arcs are formed, whilst the portion of the carbon interposed between these arcs become incandescent.

4170. "Interlocking the telegraphic block instruments with the points and signals of railways." Chas. Hodson. Dated October 15. 6d. Relates to the interlocking of the telegraphic block instruments employed on railways with the points and signals thereof in such a manner as to give greater security to the traffic. It consists of three principal organs, namely, first, of a locking handle; second, of a commutator with its plunger; third, a detent.

4976. "Apparatus for affecting telephonic communication." John Imray. Dated Dec. 5. 6d. Consists of a system of interrupters for telephonic exchange use; and also relates to the construction of the said interrupter and an indicator for use with same.

5004. "Telephones." John Imray. Dated Dec. 5. 4d. Relates to the construction of a telephone in which a permanent magnet of horse-form has one of its limbs extending across the gap between the limbs, and carrying an electro-magnet and a diaphragm with its casing.

City Notes.

Old Broad Street, March 30th, 1880.

Direct Spanish Telegraph Company, Limited.—The report of the directors for the half-year ending 31st December, 1879, to be presented at the general meeting of shareholders to be held on Wednesday, the 31st March, 1880, states that the accounts for the half-year ending 31st December, 1879, show a balance to the credit of profit and loss of £4,450 2s. 5d. The traffic receipts for the half-year are £1,847 13s. 3d. in excess of those for the preceding half-year, and £1,664 5s. 11d. in excess of those for the corresponding period of 1878. The directors deeply regret that, notwithstanding the very favourable result accruing from the increased traffic during the last six months, they are not in a position to recommend the payment of any dividend, either on the preference or ordinary shares. The shareholders may probably remember that a fault of insulation occurred in the Bilbao Cable last October. Although it did not stop the traffic, the fault, caused by the small insect known as the "teredo navalis" perforating the gutta-percha, would soon have caused a complete interruption, and it was therefore deemed advisable to have it removed at once, more especially as an opportunity presented itself of doing so under favourable circumstances as regards expense by the employment of the s.s. *Dacia*, then on her way home from Algeria. The cost of rectifying this fault, after deduction of value of recovered cable, the shareholders will find in the accounts. On the evening of the 31st December last the Bilbao Cable broke down, and, after a series of most difficult operations, its complete restoration was only effected on the 15th instant. The directors cannot ascertain the amount they will have to provide to meet the expenses of these operations until the return of the expedition, but it has been necessary to use such a quantity of new cable, and the time the ship has been occupied has been so long, in consequence of very tempestuous weather, that the

Board are under the necessity of retaining the whole of the reserve fund and the balance at the credit of profit and loss to meet their liabilities for these repairs. Since the completion of the repairs this cable is in excellent condition, and the Barcelona-Marseilles Cable continues in the same perfect electrical state as heretofore.

The accounts of the Eastern Extension Australasia and China Telegraph Company (Limited) to the 31st December last, show (subject to audit) a balance of £106,825, after payment of three interim quarterly dividends. Out of this sum the Board propose to pay on the 22nd of April, a final dividend of 2s. 6d. per share, or at the rate of 5 per cent. per annum for the year 1879, and to carry the balance of £81,856 to the reserve fund.

The Eastern Telegraph Company notify the payment of an interim dividend of 2s. 6d. per share, payable on and after April 14th.

The directors of the Brazilian Submarine Telegraph Company (Limited) have declared an interim dividend of 2s. 6d. per share, or 5 per cent. per annum, free of income tax, for the quarter ended December 31st last.

The directors of the Indo-European Telegraph Company (Limited) have determined to recommend to the shareholders the payment of a dividend for the six months ending December 31st, 1879, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year 1879, free of income tax.

At a meeting of the Board of Directors of the Anglo-American Telegraph Company (Limited), it was resolved (after placing £37,500 to the renewal fund) to declare an interim dividend for the quarter ending the 31st instant of 1 per cent. on the ordinary stock, and of 2 per cent. on the preferred stock, both free of income tax, payable on May 1st to the shareholders registered on the books of the Company on April 1st.

The Great Northern Telegraph Company proposes, at the general meeting, to be held at Copenhagen on April 24, to recommend a final dividend for the year 1879 of 2s. 9d. per £10 share, making the total division for that year equal to 6⅞ per cent., to put £44,444 8s. 10d. to the reserve fund, and to carry forward £16,242 7s. 4d.

The directors of the Western and Brazilian Telegraph Company (Limited) have arranged with the Telegraph Construction and Maintenance Company for 400 miles of cable to be laid as soon as possible.

The Western and Brazilian Telegraph Company (Limited) under date of March 5th, announce the repair of their Para Maranham section.

The Direct Spanish Telegraph Company (Limited) have announced the restoration of direct cable communication with Spain, *via* Bilbao.

The following are the final quotations of telegraphs:—Anglo-American, Limited, 59¾-60¼; Ditto, Preferred, 89-90; Ditto, Deferred, 32½-33; Brazilian Submarine, Limited, 7¾-8; Cuba, Limited, 9¼-9¾; Cuba, Limited, 10 per cent. Preference, 16-16½; Direct Spanish, Limited, 2-2½; Direct Spanish, 10 per cent. Preference, 10½-11; Direct United States Cable, Limited, 1877, 11-11½; Scrip of Debentures, 100-102; Ditto, £25 paid, 1-3 pm.; Eastern, Limited, 8⅞-9⅛; Eastern 6 per cent. Preference, 12-12½; Eastern, 6 per cent. Debentures, repayable October, 1883, 103-106; Eastern 5 per cent. Debentures, repayable August, 1878, 100-102; Eastern, 5 per cent., repayable Aug., 1899, 101-103; Eastern Extension, Australasian and China, Limited, 8¾-9; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 100-102; Ditto, registered, repayable 1900, 101-103; German Union Telegraph and Trust, 8¾-9; Globe Telegraph and Trust, Limited, 5½-5¾; Globe, 6 per cent. Preference, 11¼-11½; Great Northern, 9⅜-9⅝; Indo-European, Limited, 24-26; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 10½-11½; Reuter's Limited, 10-11; Submarine, 230-240; Submarine Scrip, 2-2½; West Coast of America, Limited, 1⅜-1⅞; West India and Panama, Limited, 1⅜-1⅞; Ditto, 6 per cent. First Preference, 7½-8; Ditto, ditto, Second Preference, 7-7½; Western and Brazilian, Limited, 7-7½; Ditto, 6 per cent. Debentures "A," 100-103, Ditto, ditto, ditto, "B," 100-103; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 32¾-33¼; Ditto, 6 per cent. Bonds, 103-107; Ditto, Second Bonus Trust Certificates, 2⅞-3⅛; India Rubber Co., 13½-14; Ditto, 6 per cent. Debenture, 106-108.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
February, 1880	*	13,517	3,200	*	*	44,591	25,190	14,160	... ...	*	a 1,300	11,490	5,410
February, 1879 ...	42,540	12,558	2,800	784	14,180	37,257	22,409	12,087	... ...	8,658	2,400	*	4,965
Increase	... ...	959	400	... ...	... ...	7,334	2,781	2,073	... ...	... ...	... ...	... ...	... ...
Decrease	... ...	... ..	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	1,100	... ...	445

* Publication of receipts temporarily suspended. a January receipts £1,225.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

Vol. VIII.—No. 173.

THE FUTURE OF ELECTRO-METALLURGY.

Perhaps no branch of electrical science has a greater future before it than Electro-metallurgy. Practical applications of the discoveries with which the general subject is inseparably connected were made at a very early date. In 1805 Brugnatelli gilded two silver medals by making them the negative pole in a solution of ammoniuret of gold. In 1839 Jacobi published a description of his famous galvano-plastic process, by which *facsimiles* of objects could be produced in copper. Since that date the progress of the art was rapid. Jordan, Spencer, and, notably, Messrs. Elkington, advanced the utility of the processes, and the latter gentlemen, whose names are widely known in connection with electro-plating, established the latter art as a profitable commercial speculation on a firm and lasting basis. Many other workers whose names are but little known, except in a small circle, have assisted in extending and refining the processes in connection with the art, and it is a matter for some surprise that a trade, which is at present of very large dimensions has attracted but little public attention. The recent issue of a monthly publication, whose object is to give to electro-metallurgy the same amount of public notice which other branches of electrical science are receiving, may, perhaps, excite more interest in the subject, which is likely to prove of the very highest commercial importance. The question of the conversion of power, by means of dynamo-electric machines, into light, heat, and motion, which has been so satisfactorily, and more or less completely, solved, has an important bearing upon the question. At a recent lecture Dr. Siemens showed the value of the electric arc for the fusion of metals, the principle involved being that of concentrating an enormous heat in and around a small space. In this particular case an instance is given of an indirect method of concentrating heat, viz., the coal is consumed in a steam-engine, and the heat generated re-appears in the form of the electric arc. If the dynamo machine were turned by water-power the same heat could, of course, be produced. Thus we should have materials melted without what is commonly understood by fuel.

Now, it is well known that in many countries the working of metalliferous mines has ceased to be attended with the profits which were formerly obtained from them, chiefly on account of foreign competition; but if it were possible to effect the reduction of the ore raised by a cheap fuel on the spot a great revival of the mining industry would ensue At the present time mining in Cornwall and Devon would be considerably advanced were fuel for smelting purposes available in the locality at a cheap rate; at present the coal for the purpose has to be conveyed at a considerable expense from a distance, or, on the other hand, the mining products have to be conveyed to the neighbourhood of the coal-pits, the expense of carriage in either case being heavy. Now, in both Devon and Cornwall the fuel exists, not in the form by which it is commonly known, but it exists in the numerous streams and waterfalls, and in the tide which surrounds their iron-bound coasts. The conversion of motive power into electricity and heat has been proved to be possible. Will some scientific and commercial genius practically apply the knowledge which has been obtained? The theoretical possibility of the idea we have suggested is, we imagine, unquestionable; its practical possibility, we think, is as certain.

Whilst advocating the application of electricity to the smelting of metalliferous ores by means of power converted into heat by electricity, we would by no means insinuate that the reduction of the ores must necessarily be effected in this way. The science of electro-metallurgy daily shows that metals may be reduced from their salts by the electric current; cannot it effect the reduction of metals from their natural earthy condition by a process equally simple with that of electro-plating, and do it in an economical manner? The motive power necessary to effect the results exists in inexhaustible quantities; it only wants to be applied. Let electro-metallurgists and electricians puzzle the question out, as we feel certain they will do in time, and another triumph will be won by means of electricity.

CROMPTON'S ELECTRIC LAMP.

In general principle this lamp possesses but little novelty; it is rather a refined and well designed arrangement adapted from old patterns, but the improvement effected by the intelligent carrying out of first principles renders the lamp one of the best yet designed.

There are two distinct movements in the lamp, by one the carbons are separated to a definite distance, and by the second they are allowed to approach together until checked by a slight increase in the current, consequent thereon.

In effecting the latter object the mechanism is made very sensitive in its action, but this sensitiveness is not obtained at the cost of simplicity and solidity of mechanism.

A general view of the mechanism will be seen from figs. 1 and 2. The starting and stopping action which allows the carbons to approach one another or to lock them, and the separation of the carbons to a definite distance in the first instance, is effected by one electro-magnet; this magnet has an armature divided into two parts—the lower and larger part, A, is attached to the rod, R_2, which forms the lower carbon holder, and has to do the rough work of separating the lower carbon from the upper one, and thus making the arc in the first instance, or of re-making it, if by any accident, such as a violent gust of wind, or breakage of carbon, it should be extinguished when the lamp is not working.

This armature and lower carbon holder is held up by a large spiral spring, S. When the current is switched on, and passes round the electro-magnet, the latter overcomes this spring, pulls down the armature and forms the arc, thus maintaining the lower carbon in a fixed position so long as there is a current passing.

The smaller variations of current, which are caused to actuate the feed of the upper carbon, are responded to by a very light plate, or secondary armature, *n*; this is hinged on to the large armature, A, and is suspended above it by a very light hair-spring, *s*, the tension of which can be varied by the regulating screw of the lamp. This secondary armature, which is formed of soft iron, carries a curved arm, *a*, which acts as a brake on the last wheel, *b*, of a clock-work train: the latter is set in motion by the weight of the positive carbon rod, R_1, which has a rack cut in it gearing into the wheel, B.

The parts actuated by the varying magnetic force induced in the armature, *n*, only weigh a few grains, and consequently are very sensitive, and it is quite usual for the armature to rise and fall six or eight times for each revolution of the brake-wheel, *b*, which represents a feed of from one to

Fig. 1.

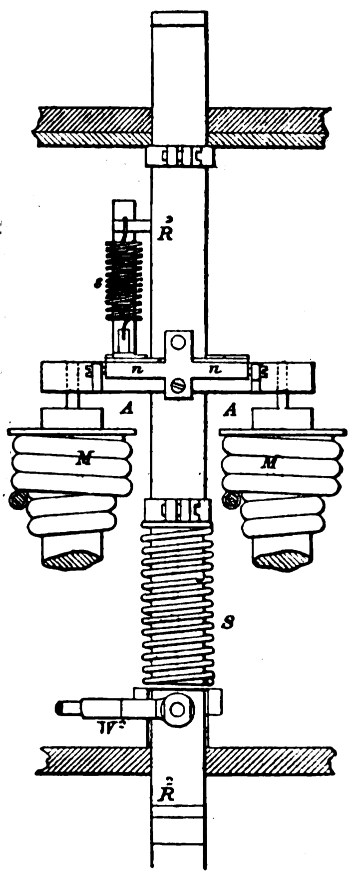
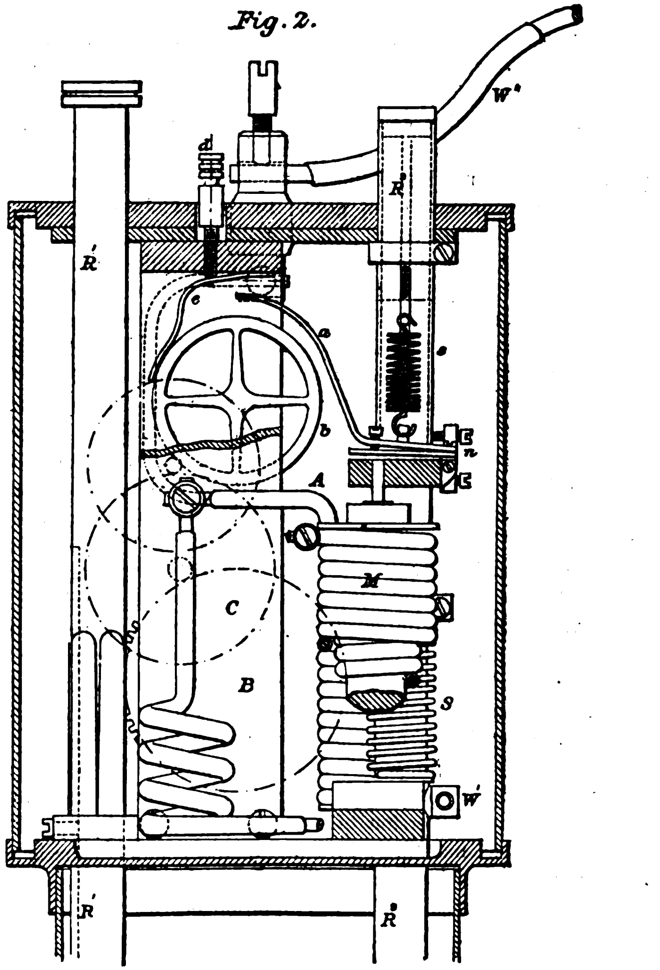


Fig. 2.



two hundredths of a millimetre; the feed, therefore, is practically continuous and causes the light to be proportionally steady.

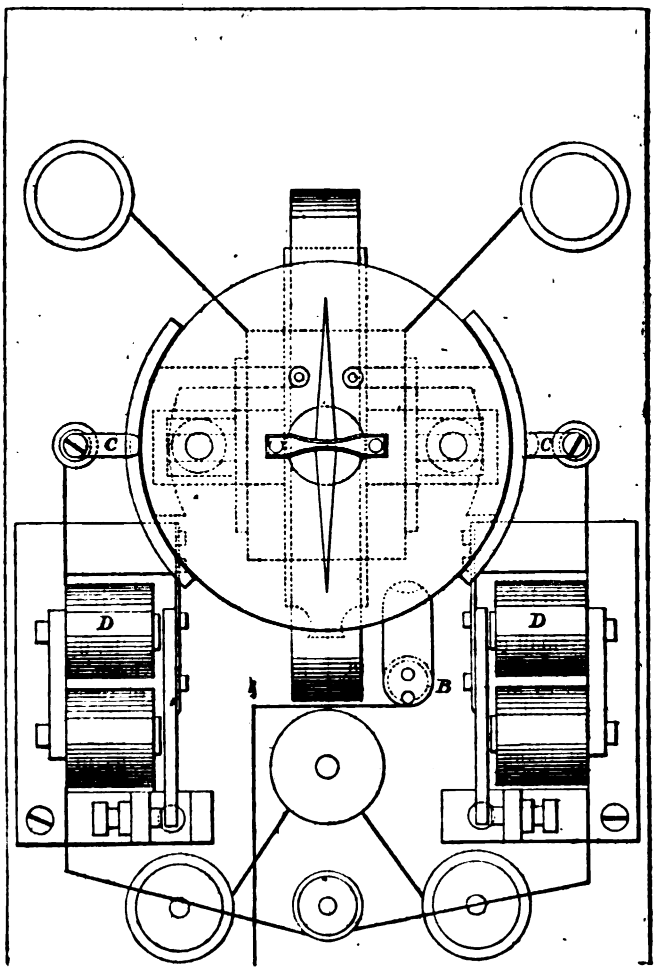
The pinion into which the wheel, B, gears is not fixed to the wheel, C, but is connected to the latter by a ratchet wheel, so that the rod, R_1, can be drawn up when it is required to insert a new carbon, without turning all the wheels in the train.

The course of the current through the electro-magnet and carbons is quite simple; thus, the current entering at W_1, passes through the electro-magnet, M, direct, thence to the frame of the apparatus and the upper carbon, and from there to the lower carbon and back to the dynamo machine.

The screw, *d*, when screwed down presses the strap, *e*, against the brake-wheel, *b*, and prevents it from turning; this is only required for security during transport.

ROGERS' PATENT NEEDLE SOUNDER.

THIS invention is intended to afford a ready means of converting the ordinary single-needle instrument into a sound-reader at will. A reference to the accompanying illustration will explain the simple and inexpensive way in which this is effected. The local battery terminal is in metallic connection with the pillar, B, which makes a rubbing contact with the dial plate. The ivory pins controlling the play of the needle are removed and replaced by platinum or silver pins soldered to brass strips at the back of the dial plate, but insulated from it by ebonite or waxed paper, and these strips are in



contact with two springs, C, leading to the sounder, S, D, the return wires from which are connected to the other local terminal. A switch is placed outside the case of the instrument in any convenient position to enable the sounder to be cut out when required. It will be seen that the needle is the current carrier, and when the sounders are switched in they reproduce its motions in sound. If desired, one sounder only can be used when the clerk can read or send the Morse Code, the spacing or time interval necessary for reading it being quite as easily produced by the tapper or drop handle as by the ordinary key. For noisy railway cabins the sounder can be replaced by a bell for calling the attention of the signalman. The sounder can be connected to the ordinary line battery in place of a separate local one if more convenient.

ON MAGNETIC CIRCUITS IN DYNAMO AND MAGNETO-ELECTRIC MACHINES.*

By Lord ELPHINSTONE and CHARLES W. VINCENT, F.R.S.E., F.C.S., F.I.C.
Communicated by Professor G. G. STOKES, Sec. R.S.

A large amount of magnetism is retained by the soft iron cores of electro-magnets when arranged so as to form a complete magnetic circuit: and sparks and other indications of the passage of an electric current can be obtained at the ends of the helix wires surrounding those soft iron cores each time the masses of iron are separated and the closed magnetic circuit opened. In order to procure a spark the breaking of the circuit must be effected suddenly, either by a jerk, tilt, or sliding movement.

In the case of the 58 lb. magnet, described in our former note, the current that is capable of causing a spark, although only momentary in duration, is found to be sufficient in quantity and intensity to magnetise a small electro-magnet, weighing, with its coils, between 5 and 6 lbs., enabling it to sustain its own weight for any indefinite time when suspended by its armature.

When the armature of the small magnet is placed at the distance of $\frac{1}{8}$ of an inch from its poles, in such a manner as to be free to move, the instant the armature of the large magnet is suddenly tilted or slid off it darts to them, the completion of the circuit of the small magnet being signalled by a smart click. The rupture of one closed magnetic circuit is thus caused to produce another closed magnetic circuit.

But when the interval between armature and magnet, whose circuit it was intended to close, exceeded $\frac{1}{4}$ of an inch, the former was not attracted with sufficient force to overcome the friction of the table upon which it was resting.

The mode of removing the armature from the large magnet appeared to be of no moment, but the time occupied by the removal had much influence upon the amount of magnetic force manifested in the smaller circuit. This was particularly the case if there were an interval, no matter how small, between the armature and the poles of the magnet round which the electric current was sent.

For example, if with an interval of $\frac{1}{16}$ of an inch between the armature and the poles of the small magnet, the armature of the large magnet was slowly slid off, the magnetisation of the small magnet never rose to a sufficient intensity to draw its keeper to itself, whereas, when the sliding took place rapidly, the small armature was strongly attracted as above mentioned.

The largest amount of magnetisation was bestowed upon the small electro-magnet by the interaction, when it was held upright, its poles being completely covered by a closely fitting armature. And it was also found that when thus set up in preparation for the formation of a closed magnetic circuit, the magnetisation was produced by a much slower motion of the large armature than when the small magnet had its circuit partly open. When the circuit was completely closed, if the large armature were twisted off by a slow equable motion, in such a manner that both poles were uncovered at the same time, then the small magnet could be made to sustain not only its own weight (between 5 and 6 lbs.) but an additional 3 lbs. also.

During the passage of the electric current, obtained by the forcing open of the closed circuit, fall of magnetism in the large magnet itself is checked, the direction of magnetic polarity remaining unchanged, the current checking or opposing the fall being in the same direction as that from the battery which caused the primary magnetisation. If the ends of the helix wires are not connected together this effect is not obtained.

Electric currents, though of less intensity and quantity, can be produced in the helices of electro-magnets, without altogether breaking up the closed magnetic circuits. For instance, with the 58 lb. electro-magnet, the circuit being completely closed by its armature, and the helices being connected with a galvanometer, a very slight pull applied to the armature produces a current of electricity, giving a considerable deflection of the needle in the same direction as the battery current; and the stronger the pull the greater the deflection of the galvanometer needle, up to the point at which the magnet is lifted from the ground, after which no further motion of the needle is produced, unless the magnet is subjected to additional strain. Thus, hanging a 4 lb. weight upon the uplifted magnet produced deflections in the same direction as the pull on the armature, and on removal of the weight, produced reverse deflections.

Trying the same set of experiments with a very small electro-magnet, so that we might proceed to absolute rupture of the closed magnetic circuit without danger to the galvanometer, we found that the addition of successive weights to the magnet while hanging suspended by its armature produced successive deflections of the galvanometer, the needle coming to rest at zero after each addition, as in the case of the large magnet.

When the maximum weight which the magnet was capable of sustaining was reached, and a real movement of the armature commenced, the in-

* Read before the Royal Society.

duced current in the helix of the electro-magnet was very greatly increased by the addition of even the smallest weight.

From these experiments it may be inferred that in like manner as the passage of an electric current round a bar of iron produces elongation of the bar, so the elongation of the bar produces in its turn an electric current in the helix; and this current tends to strengthen the magnetisation, and also that a magnet is absolutely stronger under tension than when at rest.

On the other hand, pressure on the armature, either continuous or sudden and momentary (a blow for example), causes an electric current in the helices in the opposite direction to original magnetisation, or in other words, against magnetisation; tending thereby to weaken the power of the magnet.

The 58 lb. magnet in closed circuit was hung by its armature, and on afterwards connecting its helices with the galvanometer no current could be detected, but on lowering it until it rested with its whole weight on the ground a current in the direction of demagnetisation was produced, giving a deflection of 15°. In the same way a current in the direction of magnetisation was obtained, giving a deflection of 15°, by the application of sufficient strain to lift the magnet off the ground, and this result was invariable. The degree of swing, however, depended upon the rapidity with which the magnet was either raised or lowered.

It may be remarked that whereas any very slight application of force by pulling on the armature was sufficient to cause a current in the helices giving a deflection of 5° to 10° of the galvanometer needle, a great amount of pressure is necessary to produce a similar deflection. A slight pull with the finger and thumb in the one case was equal to the pressure of a hundredweight in the other.

By the momentary removal of the armature, the closed magnetic circuit is broken, and though by its immediate restoration a new closed circuit is formed, nevertheless the tension on the molecules of iron by the magnetic stress is very greatly reduced. Under these conditions a very slight pressure upon the armature produces a great swing of the needle, whilst a pull produces scarcely any effect at all until actual movement of the armature takes place.

If the pressure on the armature is great and continuous, a point is soon reached at which a slight pressure is no longer effective.

The effects produced are somewhat different if pressure is applied unequally. For instance:—A weight of 7 lbs. placed on the armature over the north pole of the 58 lb. magnet caused a current in the helices giving a deflection of 20° at the galvanometer. The same weight on the south pole gave the same deflection in the opposite direction. Pressure with the hand produced like swings of the needle proportionate to the force used, and the amount of swing can be easily controlled and the needle brought to rest by judicious pressure on either pole of the magnet.

If a lateral pressure be applied to one side of the armature between the poles, and the needle swings, say, 5° on removal of the pressure, a current is produced in the opposite direction, and the reverse swing in place of being 5° will be 8°, and so on in proportion to the amount of force made use of.

None of the above-mentioned effects could be shown with the small magnets under pressure; and it was not found possible to produce a recognisable current without actual movement of the armatures.

Under certain circumstances the attractive force of electro-magnets in closed magnetic circuit is found to increase with lapse of time. For example:—A small U-shaped electro magnet with limbs 6 inches long, having a core of ⅜-inch iron, and helices consisting of four layers of No. 16 covered copper wire, when excited by four Bunsen cells, supported as an armature a similar U-shaped iron bar, but without a helix upon it; this latter remained firmly attached after the voltaic current had ceased, but the hanging on to it of an additional weight of 3 lb. 6 oz. instantly wrenched it away from the electro-magnet, and broke the closed magnetic circuit.

The magnet was then re-excited, the armature being fixed to the electro-magnet by being held in contact with the poles whilst an electric current, of a few seconds' duration, passed through the circulating wire. In place of immediately attempting to add any additional weight, the two iron U's were left hanging face to face, in the form of the link of a chain, for twenty-four hours, at the end of which time the weight of 3 lbs. 6 oz. was hung on and sustained. Forty-eight hours later, an additional weight of 3 lbs. 10 oz. was carefully added, making in all 7 lbs. sustained. Twelve hours afterwards 1 lb. more was added, bringing up the entire weight to 8 lbs. beyond that of the armature; this was suffered to remain for five days, when the system was taken to pieces.

On a subsequent occasion the same magnet sustained an entire weight of 10 lbs. beyond that of the U-shaped armature, the weight sustained being reached by beginning with an amount well within the sustaining power of the electro-magnet wire in closed circuit, and increasing it by small additions made with intervening intervals of time varying from twelve hours to several days.

Another and smaller U magnet was likewise experimented on; this weighed with its coils 3 lbs. 6 oz. Its armature was a strip of soft iron completely covering the poles, and having a hook in the centre, to which weights could be easily attached.

This electro-magnet was excited by the passage, for a few seconds, of the current from two one-pint bichromate cells. On breaking battery contact, the armature failed to sustain 4 lbs. The electric current was again sent round the electro-magnet, and the armature was pressed against the poles, being carefully adjusted so as to cover them completely, and at the same time to place the hook precisely in the centre, so that the pull should be fair and equal when a weight was hung upon it. By this careful manipulation, on breaking contact with the bichromate cells, the closed magnetic circuit was found capable of sustaining the 4 lb. weight.

By successive additions of 2 oz. weights, made at intervals of a few minutes, the weight hanging to the armature was raised to 5 lbs., after which the attempted addition of 2 oz. caused the disruption of the system.

The experiment was repeated under similar conditions, but with slightly extended intervals of time between the additions of the weights. The magnet

in closed circuit was made to hold 4 lbs. 2 oz., 4¼ lbs., 4½ lbs., 4 lbs. 14 oz., 5 lbs. 2 oz., the time taken in all, for the successive additions, being ten minutes. The system was then left for twelve hours, when by additions of 4 oz. at intervals of a few minutes the weight sustained was increased to 6 lbs. 4 oz. Eleven hours later this was further increased to 7 lbs. 6 oz., and two hours afterwards, to 8 lbs. 2 oz.

A still smaller electro-magnet, weighing with its coils 5 oz., and having an armature consisting of a very thin slip of soft iron, when excited by one of the bichromate cells, could not be made when in closed circuit to sustain 1½ lb. at the moment of breaking the voltaic circuit. It, however, sustained 1 lb. with ease. The latter weight was therefore suspended, and the cell wires removed after the closed magnetic circuit was completed. By successive additions of 2 oz. weights at short intervals of time (five minutes to ten minutes each), this small magnet could be made to sustain 2 lbs. 2 oz., but the addition of 1 oz. beyond this weight at once separated the armature and magnet. It was thought that a longer interval of time should, as in the former instances, enable the magnet to sustain a still greater weight. It was therefore brought into closed circuit, as before, and made to sustain 2 lbs. 2 oz. in the manner just related, and was thus left for twelve hours. Successive additions of 2 oz. were then made to the hanging weight until it reached 2 lbs. 14 oz. Twenty-four hours afterwards, 4 oz. more were added, bringing the entire weight suspended to 50 oz.

This small, soft iron magnet which, at the instant the voltaic current was withdrawn, was totally unable to sustain five times its own weight, was thus, by gradual growth of its magnetic force, enabled to hold ten times its own weight.

(To be continued.)

THE ELECTRIC DISTANCE MEASURER OF M. G. LE GOARANT DE TROMELIN.

The question of the rapid measurement of the distance separating a moving object from a point of observation, has often been considered by various inventors. The problem resolves itself into this: There being two given points of observation, O O′, separated by a distance of say 1,200 metres, to find immediately, and without calculation, the distance of a movable point, N (see fig. 1), from the observatory, O. If O O′ represents the base of 1,200 metres, and O A the distance separating the limit, L, of the centre of rotation of the pointer, A *a*, it is evident that if A *a* is parallel to O′ N, the triangles, O *n* A and O N O′, being similar, *n* O will represent on the table, T T, the distance of O from N on the same scale that O A bears to O O′.

This being granted, suppose that from the two observatories, O O′, the telescopes, L and L′, are turned towards the point, N; then if by electrical means we cause the pointer, A *a*, to move always parallel to the telescope, L′, the two similar triangles, of which we spoke, will always be automatically formed, and the point of intersection of the pointer, A *a*, with the graduations, R, engraved on the telescope, L, and which are graduated to the scale of $\frac{\text{O A}}{\text{O O}'}$ will give at once, by a direct reading, the distance, O N, which is required.

In order to obtain parallelism between the telescope, L′, and the pointer, A *a*, let us suppose a toothed sector, S, to be fixed to L′, and made movable by means of a tangent screw, V, turned by a handle, M.

The telescope, L, and the pointer, A *a*, are set parallel once for all when the instrument is adjusted. A wheel, P, fixed to the axis, *b b*, of the tangent screw, and provided with an interrupter, I, can produce a number of interrupted currents, so that the escapement of a receiver, regulated by the wheel P, causes the pointer, A *a*, to follow the angular movements of the telescope, L′.

This principle has been effected by various persons; the object aimed at has been the same, but the means by which they have been arrived at are very different.

M. Siemens, well-known by his electrical inventions, has employed the armature which bears his name to effect this result.

On the axis, *b b*, he placed a multiplier wheel, connected with his armature, which turned between the poles of a powerful magnet.

By making the sector, S, turn, he produced at the same time a rotation, more or less rapid, of the armature, which produced reversed induced currents at each half revolution. These currents, transmitted to the receiver, O, constituted a motive force which caused the movement of the needle, A *a*, by means of a system of propelments, driven by an armature oscillating between the branches of an electro-magnet, polarised by a magnet in V.

This system was, as is evident, the application of the *transmission* of force to a distance by the magneto-electric machine which M. Siemens had invented.

Although ingenious, this system possessed a great defect; in fact, it was impossible to produce a sufficient current without exerting considerable manual exertion, and this was aggravated by the multiplying power of the wheel work. If the manipulator was turned slowly, the currents induced had not sufficient power to move the pointer, which was nearly a metre in length. If the apparatus was turned too quickly, the number of currents transmitted was so considerable that the propelments did not respond at all in consequence of the inertia of the long pointer, A *a*. In any case the motive force was so slight that the wind alone was sufficient to prevent the pointer moving, and consequently parallelism from being preserved.

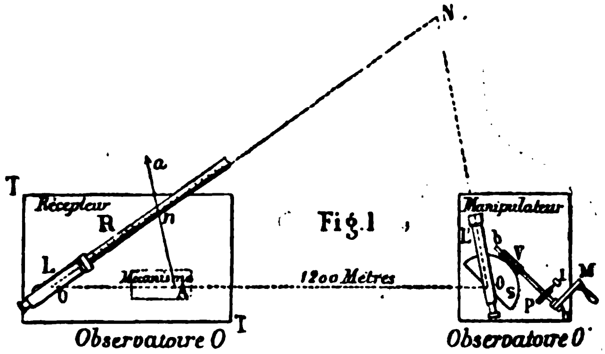
This system was tried for some time at Brest, and had to be given up.

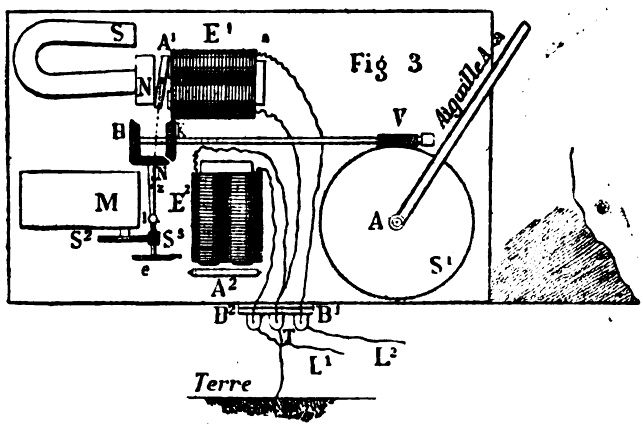
We have spoken at some length about this *telemeter*, because it is one of the first applications of the transmission of force to a distance, and because it was in France that it was first applied; in fact, because it had features distinct from similar forms of apparatus.

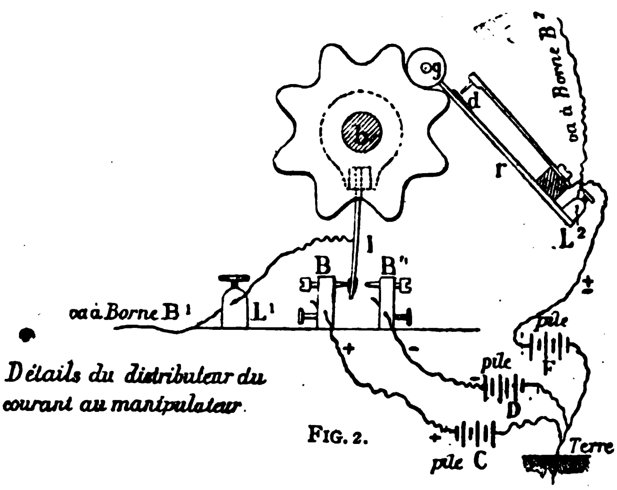
The inconveniences which we have pointed out do not exist in the telemeter of M. de Tromelin. The electricity being only used for regulating an escapement driven by clockwork, it is evident that the motive force can be sufficiently consider-

able to effect the object aimed at. The problem to be solved is that of the movement of the pointer, A a, in the two directions. It is necessary that the observer, having followed a particular point with the pointer in one direction, shall be able to follow any other point by using the pointer in the reverse direction.

Description.—The manipulator is made as shown by fig. 1; fig. 2 shows details of the same. As can be seen, the wheel, P, has 8 cams, which, by raising the jockey wheel, *g*, during the rotation of the former, produces at *d* interruptions of the current given out by the battery, F, and which flows to line, B. The spring, *r*, is sufficiently strong to cause the jockey wheel, *g*, to lie in the hollow of the cam wheel when the handle which turns the wheel round is left to itself. A reverser, I, mounted friction tight on the axis, *b*, allows either the positive







Détails du distributeur du courant au manipulateur.

FIG. 2.

pole of the battery, C, or the negative pole of the battery, D, to be in connection with I, according as the cam wheel is turned in the one direction or the other, and thus causes either a positive or a negative current to flow out to the line-wire, B′.

Fig. 3 represents the receiver; the whole of the wheels are not shown, but the principal pieces are indicated, and they are sufficient to enable the action of the apparatus to be understood.

When the manipulator is turned to the right, for example, the current from the battery, C, is sent through the electro-magnet, E^2, and the escapement, *e*, connected with the clockwork, M, is regulated by the armature, A^2, in the same manner as is the A B C telegraph of Breguet. The clockwork movement being geared with the wheel, S^2, and thence with S^3, which latter carries the escapement, *e*, tends to turn the piece I and the piece M^2, the latter being connected with S^3 by a universal joint, I.

On *z* is the bevil wheel, N; this wheel gears with the bevil wheel, H, and turns the axle, H V, and the latter by the screw, V, gearing into the wheel, S, causes the pointer, A *a*, to turn.

If the direction of the movement of the pointer is changed the manipulator is let go for a moment and then turned in the reverse direction.

Now, as the jockey wheel lies in the hollow of the cam wheel, the reverser, I (fig. 2), moves over to the terminal, B″, before the circuit can be closed through L^2 and the line, B^2, hence it follows that the movement of the armature, A^1, takes place before that of armature A^2.

The current which passes in the electro-magnet, E_1, changes its direction with the change in the direction of the movement of the handle, M; the poles of the electro-magnet, E_1, also change their polarity. As the armature, A^1, is polarised by a magnet and oscillates on its centre, it can assume two positions corresponding to those of the reverser, I.

This armature, A^1, moves to the right or left by means of a lever, which we have represented by a dotted line, the bevil wheel, N; it can be seen, therefore, that the latter can gear either with H or with K, according as the handle, M, is turned in the one direction or the other, determining thus the rotation of the pointer in either direction. Its successive movements are equal to an angle of 1′ 52″, 5.

The batteries employed are three boxes containing six Leclanché elements.

This system has worked very well at Lorient, where a Marine Commission had been directed by the Minister of Marine to experiment with it.

The instrument can be used with great advantage in forts, so that the distance of moving objects at a distance can be determined with considerable accuracy.

The rapidity of the indications of the distances cannot be surpassed; its precision is considerable, since the base line can be long, the scale alone is reduced. The parallelism being always vigorously maintained automatically, the error can only be very little, being dependent upon the smallness of the possible angular movement of the pointer, and, as has been pointed out, these movements are very small.

The channels defended by Whitehead torpedoes can also utilise it with advantage, since, in this special case, the velocity of the moving ship could be determined, so that the routes of the torpedo and the moving ship may cross at the right moment.

This ingenious apparatus, which has been an object of favourable report by the Marine Commission, has been constructed by M. Dumoulin-Froment.
—*La Lumière Electrique.*

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

VII.

Relays (*continued*).

Varley's Relay.

At the time Mr. C. F. Varley was in the service of the Electric and International Telegraph Company he invented and introduced a form of relay which has given very satisfactory results. Although not so good an instrument as the *Standard* Relay, and consequently to a certain extent being an obsolete form, yet a large number of the kind are still in use in the Postal Telegraph Department.

The principle of the instrument will be seen from fig. 34, which shows in outline, a plan, side elevation, and end elevation of the arrangement.

C, C_1, are two ordinary magnet bobbins without cores; within the former is placed a long soft iron core, *b b*, the diameter of the latter being such that it can have a small amount of lateral play within the hollows of the bobbins. This core is pivotted at its centre by means of an axle, *a*, *a*. The ends of the soft iron core play between two permanent fixed steel magnets, M, M_1, the relative positions of whose poles are reversed to one another. Now if a current is sent through the wire on the bobbins, the soft iron core becomes magnetic and is attracted and repelled by the poles of the permanent steel magnets, so that it turns on its axis in one direction; if the current is reversed through the coils then the angular movement is in the reverse direction. The lateral play, or angular movement, is limited by the screw stops, S_1, S_2, the former of which has an insulated tip; the latter is connected to a terminal corresponding to the M terminal in the other form of relays; the bar itself is connected in like manner to a terminal corresponding to the L Z terminal. The coils, C, C_1, are connected to two terminals only, these relays not being differentially wound, as they were constructed previous to the introduction of duplex telegraphy, and being of an obsolete form, it has not been considered advisable to rewind them for that purpose.

The resistance of the wires on their coils averages about 300 ohms. The adjustment of the piece carrying the screws, S_1, S_2, was formerly effected by simply shifting a brass tail-piece similar to the balance regulating hand on a watch. This rough mode of adjustment has recently been improved by the addition of the ordinary adjusting screw employed in the other form of relays; it is difficult to understand why a screw adjustment was not fitted in the first instance.

The general form of the Relay is seen from fig. 35, the glass shade which covers the instrument being normally removed.

Fig. 34.

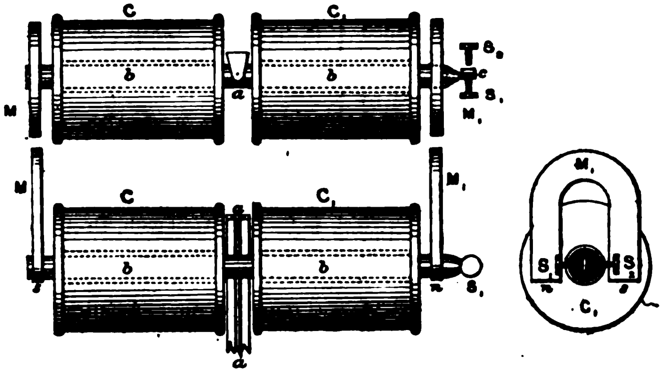


Fig. 35.

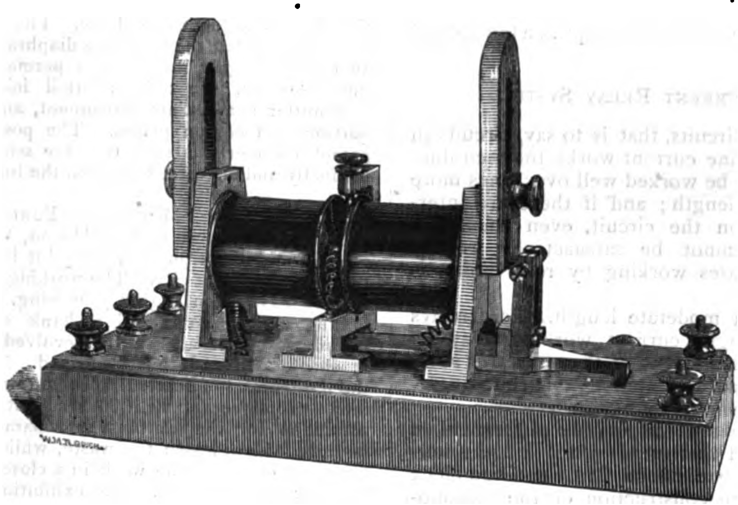
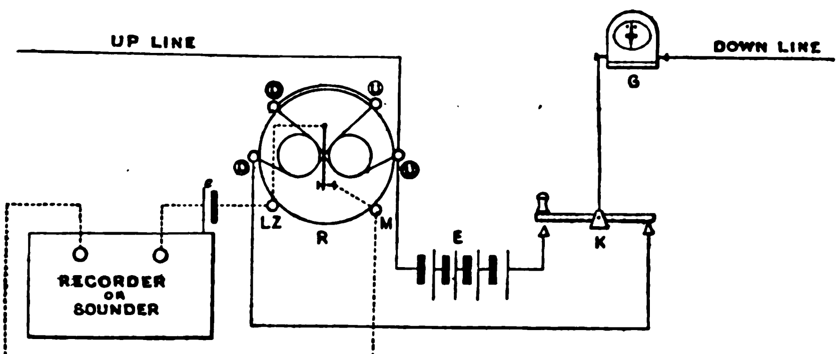


Fig. 36.



Although a somewhat bulky and clumsy-looking form of instrument, the Varley Relay is a very good working apparatus; it will work well with 1 milliweber of current at ordinary key speed. Its good working qualities are due in the first instance to its perfectly balanced movable core or armature, also to the rigidity of the latter. Again, there is but little tendency for the long rod form of core to retain residual magnetism, especially as it is not polarised by a large permanent steel magnet as in the Siemens' form of relay.

The inertia which a long and comparatively heavy rod must possess renders the instrument unfit for high-speed working; but as this is not required in ordinary key-worked currents it is not a disadvantage.

Besides the foregoing Relays, there are one or two other forms used here and there in the Postal Service—the Theiler,* for instance. There are also a few of the Bright's bell form † with single tongues. The number of these miscellaneous instruments is, however, so small, that they can hardly be considered as forming part of the general apparatus, and they will not, therefore, all be alluded to.

It may be mentioned that *un*polarised relays are not used in the Postal Service except in a few special cases.

SINGLE CURRENT RELAY SYSTEM.

Direct Writing Circuits, that is to say, circuits in which the direct line current works the recording instrument, cannot be worked well over lines more than 100 miles in length; and if there are intermediate stations on the circuit, even lines of a shorter length cannot be satisfactorily worked direct; in such cases working by relay must be resorted to.

For circuits of a moderate length, where relays are necessary, single current working may be adopted. The arrangement of the apparatus at an "Intermediate" station, worked on the single-current system, is shown by fig. 36.

G is a galvanometer, the *right*-hand terminal of which is connected to the "Down" line, the left-hand terminal being connected to the hinge block of the key, K. The construction of the galvanometer possesses no peculiarities; the instrument, in fact, is very similar in construction to an ordinary single-needle dial. The key, K, is similar in construction to the one attached to the Direct Writing instruments, but is fixed on a small base by itself, so that it can be screwed down to any part of the desk on which the instruments are placed.

The relay R has its two terminals, D_0 and U, connected together. Terminal D is connected to the back stop of the key, and U_0 is connected to the "Up" line and to the "Zinc" of the battery. At an "Up" station terminal U_0 will be connected to Earth and the right-hand terminal of the galvanometer to "Line," and at a "Down" station the right-hand terminal of the galvanometer will be connected to Earth and terminal U_0 to "Line." Some of the older relays are wound singly, and have their terminals marked 5 and 6; these numbers correspond to D and U_0 respectively.

The Recording instrument, if it is a Morse, is similar in construction to the Direct Writer apparatus, only, of course, it is not provided with a key or galvanometer; the coils are wound to a resistance of 40 ohms, and a 10-cell Daniell battery is used as a "Local" to work it.

* *Telegraphic Journal*, Sept. 1st, 1877.
† *Telegraphic Journal*, Feb. 15th, 1880.

Notes.

AT the meeting of the Society of Telegraph Engineers, to be held April 28th, Dr. C. W. Siemens will read an original paper on "Dynamo-electric Machines and their Applications."

THE 1877 Anglo-American Cable between Ireland and Newfoundland broke on the evening of April 2nd, 36 miles from the Irish coast; the depth of the water at this point is 80 fathoms. A repairing ship has been despatched to restore communication.

SOME experiments have been tried at Melbourne, Australia, with a new patent telephone, invented by Mr. J. E. Edwards, of Melbourne, and called by him the electro-magnetic telephone. The chief feature of the patent is that the receiving diaphragm is moved by an electro-magnet instead of a permanent one, as is the case with the ordinary Bell instrument. The transmitter is a distinct instrument, and the principal portion is a carbon pencil. The power of the new patent receiver was such that the sender's voice was distinctly audible three feet from the instrument.

THE ELECTRIC MIDDLINGS PURIFIER.—A public exhibition was given in New Haven, March 13, of the electric middlings purifier, the joint invention of two young men of that city. The working of the device is said to have been highly promising. Over the wire bolting cloths are placed a bank of hard rubber cylinders, which are slowly revolved against strips of sheep skin and thus electrified. To these rollers the light bran is attracted, to be mechanically brushed into a proper receptacle. This substitution of electric attraction for the air blast in separating bran from flour is said to lessen the waste, while it obviates the necessity of doing the work in a closed chamber and the risk of explosions. The exhibition was made in an open room, and there were neither dust nor waste.—*Scientific American.*

THREE sets of pneumatic clocks are to be tried in Paris, viz., Breguet's, Garnier's, and Redier's. An electric system of Leverrier will be tried in competition with the pneumatic systems.

A SERIES of experiments in spectrum-analytical comparison of gas, sun, day, and the electric light has been lately made by Herr Meyer (Carl's *Zeitsch. für angew. Electr.-Lehre*, 1, p. 320, 1879). He used both Vierordt's method and a method first suggested by Bohn; in the latter a Nicol prism is fixed before one half of a slit and receives the light from one source; behind it is the Nicol, rotatable in a graduated circle of Wild's polaristrobometer. The light beam passing through both prisms strikes a rectangular glass prism, which reflects it into the spectrum apparatus. The second slit-half is illuminated either directly or through a second rectangular prism from the second light source. The numbers show that the brightness of the colours in the gas-spectrum, compared with that in sun or daylight and the electric

light, steadily decreases from the red to the violet end of the spectrum. As sunlight is considerably brighter in the middle parts of the spectrum than the electric light, the latter should appear yellow with the former; and in a Ritchie photometer the surface illuminated by the electric light did indeed appear yellow like an orange, in comparison with that illuminated by the sun. Another interesting fact elicited is that in day-light there is comparatively more red and yellow, and less blue and violet light than in sunlight.—*Nature.*

TELEPHONIC communication will be opened during the summer months between the top of the Drachenfels and Königswinter, on the Rhine. The apparatus will be fitted up by the German Postal and Telegraphic Department.

AT a recent meeting of the Scientific Committee of the Royal Horticultural Society, a number of specimens of flowers and vegetables were exhibited which had been grown under the influence of the electric light by Dr. Siemens. The specimens were of five descriptions, viz., pots of seedling mustard, buds of the Countess of Oxford rose, spathes of Calla Æthiopica, and pots of carrots. The first specimens grew with equal vigour when exposed either to the electric or to solar light, those exposed to the electric light, however, were the darkest in colour. The two second descriptions grew with greater vigour when exposed to the electric light. The carrots grew equally well under either conditions, but when exposed to both the electric and solar lights they flourished more vigorously.

THE ELECTRIC LIGHT IN INDIANA.—A contract for a 10,000 candle-power electric light, to be placed in the dome of the County Court House, at Wabash, Indiana, and intended to light that city, has been let to the Brush Electric Light Company, of Cleveland, Ohio, for 1,800 dols. The agreement provides that, should the light prove unsatisfactory, the city shall be at no expense. A guarantee for a perfect light has been given by the company.

THE telegraph line between Fort Beaufort and Natal is to be duplicated, this addition having been found necessary in consequence of increase of work arising from the messages arriving by the Cape Cable. The existing line has considerable local traffic on it, as it has several stations on its circuit.

TELEGRAPHIC RATES.—The revised tariff for telegrams, which took effect on the 1st of April, is as follows:—Austria, 4½d. for each word; Belgium, 2d.; Denmark, 4d.; France, 2½d.; Germany, 4d.; Greece, 7½d.; Holland, 3d.; Hungary, 5d.; Italy, 5d.; Norway, 4d.; Portugal, 6½d.; Russia in Europe, 9d.; Spain, 6d.; Sweden, 5½d.; Switzerland, 4d.; Turkey in Europe, 8d.

THE MEXICAN TELEGRAPH COMPANY. — The Mexican Telegraph Company has been organised under the laws of New York, for the purpose of establishing telegraphic communication with Mexico and Central and South America. Arrangements have been made by the company for acquiring a concession granted by the Mexican Government, by which the control of all foreign messages to and from places in Mexico, south of a line 156 miles south of the boundary line of the United States, is secured *exclusively* for the term of 50 years, and the right of establishing and working telegraph cables between the United States, Central and South America, *via* Mexico, is secured for 50 years, during which time the Government of Mexico binds itself not to grant to others like privileges. Negotiations are in progress for the extension of telegraphic communication to Guatemala, San Salvador, Honduras, Nicaragua, Costa Rica, Panama, U. S. of Columbia, Ecuador, connecting exclusively with the lines of this company, and the established lines from Payta, Peru to Chili and Brazil, on terms very beneficial to the company. The present undertaking of this company will consist of about 500 miles of submarine cable (with no land lines), which will begin on the southern coast of Texas, and be continued to the cities of Tampico and Vera Cruz, Mexico, connecting there with the Mexican Government lines built over the railway to the City of Mexico, from which point 7,300 miles of wire extend to all important cities of that Republic. Mr. James A. Scrymser is President and Senor Don Ramon G. Guzman, Resident Vice-President for Mexico. — *Journal of the Telegraph.*

A TELEPHONIC exchange is to be established in Madrid.

A CONTRACT for laying a submarine cable across the Gulf of Mexico, connecting the United States with the Mexican Republic, has been approved by the Mexican Congress.

THE publication mentioned in the leader of the present number as being conducted in the interest of Electro-metallurgy is entitled, "The Electro-Metallurgist," and is issued by Messrs. J. A. Brook and Company, of 282, Strand.

A NEW paper, stated to be in the interests of telegraphy, has been started in Philadelphia. It is entitled *The Magnet*, and contains much that is interesting or amusing, but we note little of scientific matter. Apparently the intention is to entertain rather than to instruct. We wish its editor every success.

THE French newspaper *La France* says:—"The members of the jury of painting for the forthcoming Salon have drawn up a protestation against the employment of the Jablochkoff light."

THE MAGNET IN MILLING.—The truth is, that the introduction of magnets as a grain-cleaning agency opened the eyes of millers to a few facts of which they had been ignorant before. They had been perfectly cognisant of the damage done by wire in wheat, but no one expected such a revelation as the use of magnetic separators gave us all. Most of us knew that the magnets would show that wire existed where its presence was never suspected; but who would have looked for such a collection of metallic odds and ends as these separators bring to light? In the course of a day a large merchant mill will take from its wheat, by means of magnets, a miniature junk shop. You will find everything represented, from tenpenny nails down to bits of iron as small as a pin-head. How all of it got into the wheat is a mystery; but one thing is certain, that much of this iron must formerly have gone to the burrs and bolts, and if the wire binder had never been invented magnetic separators would find a useful place in every mill. But the wire binder has come to stay. Revolutions do not go backward, and it is not at all likely that the farmer will ever again rely upon "tramp" labour in harvest after once having had his wheat gathered by one of these binders. Therefore we must expect wire in our wheat along with nail-heads and other rural products. So far, the magnet is the only effective means discovered by which the miller can remove wire from his wheat, and

therefore, the magnet and magnetic separators are probably as much of a permanency in milling as the wire binder is in agriculture.—*American Miller.*

By a recent improvement, M. Chambrier, of Charleville, claims to have increased the power obtainable in electro-magnets. The new form of magnets have enlarged attracting surfaces. In one arrangement the poles of the magnets are made hollow, and in the cylindrical cavity so formed, which is a few millimetres in depth, a small piece of copper or other non-magnetic metal is inserted. The armature is so channelled with annular cavities as to fit into these hollows, the copper in the latter preventing magnetic contact. The increased pull between this form of armature and the hollowed cores is said to be due to a similar action to that which causes a bar of iron to be sucked into a solenoid through which a current is passing. M. Chambrier states that an increase in pull of over 50 per cent. is obtained by this form of magnet and armature.

A New York correspondent of the *Standard* says: "That of the 200 paper carbon lamps tried by Mr. Edison, only two remain at present undestroyed. A professor of Harvard University has sent him 50 specimens of fibres to test for the carbon horse-shoes instead of the paper formerly used. Mr. Edison finds manilla is the best of them for his purpose." Amongst those who have the best opportunity of judging what he has done, or is likely to do, little hope seems to remain of his ultimately attaining success with his incandescent lamps.

Mr. Barlow, of Doctor's Commons, kindly forwards us the following notes relating to Patent Laws:—

U.S. American Patents.—As an American patent expires at the same time as the prior foreign patent (for the same invention) having the shortest term, applicants for patents must, according to section 4,887 of the "Revised Statutes," set forth in the oath accompanying the petition and specification, either the date and reference of prior patent, or that no such other patent has been obtained or applied for, according to the case. As a U.S. patent is granted for a term of 17 years without annuity or further payment, it would appear advisable for inventors to first secure their patent rights in that country, before securing other foreign patents.

Austro-Hungarian Patents.—Another change in Patent Laws which is of importance to inventors is that in Austro-Hungary, whereby the procedure is much simplified, viz.:—The Austrian Ministry of Commerce have decided that henceforth *Foreigners* applying for Austro-Hungarian patents are not required to furnish a legalised copy of prior "*Foreign Patent*," nor will it be necessary to prove to the authorities that the Austrian patent has been worked within the prescribed term, as has hitherto been the case, although the proper working must not be neglected.

Trade Marks in Switzerland.—The Swiss Federal Council has passed a Trade Marks Registration Act, by which trade marks, having been properly registered abroad, will receive full and complete legal protection in Switzerland. *Proprietors of old trade marks should apply for registration before 9th April,* 1880, or as soon as possible afterwards, in order to secure their priority.

Mr. Cyrus W. Field is said to intend starting shortly for a tour round the world. He has worked hard for 45 years, and thinks he has earned a right to some pleasure.—American *Operator.*

M. Fromme finds that a Grove's battery is most efficacious when the nitric acid contains 40 per cent. of water; the "strength" of Bunsen's decreases with the concentration of the acid; and that of Daniell increases with the concentration of the sulphate of copper solution.

Toughened glass M. Ducretet finds to be an excellent material for leyden jars, as it offers a greater resistance to a disruptive discharge than ordinary glass. In consequence of this fact, leyden jars can be made comparatively thin, and so have a greater capacity without the risk of the dieletric becoming pierced by a discharge.

Cardboard covered with a film of collodion may be used with advantage in the place of the ordinary resinous cake or ebonite plate arc for the "electrophorous." This discovery, made by Professor Borlinetto of the University of Padua, is said to yield excellent results, the sparks obtained from the apparatus being decidedly longer than those given out with the ordinary exciting plate.

A correspondent to a contemporary states that he has successfully deposited bismuth on iron and steel from a solution of the ammonia-citrate of that metal. The solution may be prepared as follows:—Dissolve metallic bismuth in strong nitric acid. To this solution add ammonia or carbonate of ammonia as long as any precipitate occurs. Next, filter and wash this precipitate and dissolve it in a strong hot solution of citrate of ammonia. This solution must be used hot (at a temperature of 150 to 180 degrees Fah.), with an anode of bismuth about the same size as the cathode, and a battery of about a couple of Daniell's cells. The cathode may be easily cast in a shallow cardboard tray, and should be ⅛ in. thick, and have a copper wire cast in it for connection. Two ounces of bismuth will furnish an anode of 4 square inches. He has also used the sodio-potassio-tartrate of bismuth in solution with the same success, but he deems the above equal in results and easiest made.

Chasse's Multiplex Telegraph.—For some months a Frenchman, named Chasse, has been promulgating the most astonishing claims with regard to an alleged new process of telegraphing, by means of which an indefinite number of messages might be sent simultaneously in opposite directions over a single wire. A few days ago practical telegraphers were invited to witness a demonstration of the process at the inventor's workshop in Hartford, Conn. There were eighteen telegraphic instruments at each end of the room, all connected with a single wire, supposed to represent a cross country line. Eighteen messages were sent each way, all at once, apparently through the single wire. Among the witnesses was Mr. William Hadden, of the American Union Telegraph Company, who noticed that the insulated connecting wires were neatly fastened to the wall by double-pointed carpet tacks. On pulling one out he found that beneath each tack the covering of the wire had been neatly cut away, and an ingenious system of false circuits established by fine wires leading from the tack legs. The supposed cross-country wire was a sham, and the too promising multiplex telegraph a clever cheat.—*Scientific American.*

Roumania has given her adhesion to the International Telegraphic Convention of 1879, and the new tariff will come into operation in that country on April 1st.

The material known as Parkesine, Celluloid, or

Xylonite, is now manufactured by the "British Xylonite Company." This material has considerable electrical insulating properties, and may be used with advantage in many cases where ivory or ebonite are at present exclusively employed. Although the material was introduced several years ago, it has only recently been so far improved in manufacture as to become a useful material for electrical and other purposes.

The New Sawyer Electric Lamp.—"This lamp," says the *Scientific American*, "based upon the incandescence of a pencil of carbon immersed in nitrogen gas, is in no way different in principle from the Bouliguine or the old Sawyer-Mann lamp exhibited some years ago. The pencil is contained within a globe two inches in diameter and ten inches high, sealed at the bottom by means of a cement, which, while adhering perfectly to the glass and metal, is sufficiently elastic to compensate for the unequal expansion of the two. It softens only at a temperature of 500° Fah. The globes are charged by the process invented some time ago by Thomes B. Stillman, which is so simple in its details and so rapidly operated that a single workman can prepare fifty lamps per hour at a cost of about thirty cents, in such a manner that according to Stillman's calculation, the amount of atmospheric air remaining is only an infinitely small fraction of the normal quantity. The cost of the nitrogen is stated at eight-tenths of one cent, and that of its purification as one and one-fifth cents; the total cost of recharging a lamp, when the nitrogen is exhausted or becomes mixed with air, being, inclusive of the wages of the workman, two and three-fifths cents, against a cost of seventy cents for the process usually employed. The carbon pencil, seven inches in length and about three thirty-seconds of an inch in diameter, is fed upward as fast as disintegration takes place at the point of contact, by means of a regulator, which will be substituted by an automatic feeder as soon as the arrangement can be perfected. Mr. Sawyer says that one of these pencils, used for five hours a day, will last at a minimum calculation from his experiments, not less than ninety days, and, at a maximum, for two years. The cost of the pencil is a trifle less than two cents, and the cost of replacing and recharging with nitrogen nine and three-fifths cents. The bag of sodium and the large spiral conductors at the base of the carbon, which were distinguishing features of the Sawyer-Mann lamp exhibited about a year ago at No. 94, Walker-street, have been discarded. Two small steel rods take the place of the latter. The globe, which is not unlike the chimney of an ordinary kerosene lamp in general appearance, is imbedded in a nickel-plated base, which may be highly ornamented or not, according to the taste or means of the user. Photometric tests, it is said, have been made with a Sugg photometer, such as is used by the gas companies for the same purpose, and each light was registered as equal to twenty-seven and five-tenths standard candles, or a little more than twice the value of a five-foot gas burner, which usually registers from ten to twelve standard candles. Mr. Sawyer claims that his system of distribution is entirely novel and original, but declines for the present to give a description of it, his patents not having been as yet secured. The regulator, we are told, is based upon the plan used by the old Berlin house of Siemens Brothers, by which only such a volume of current is supplied as is necessary to overcome the resistance. The light is readily toned down to a glimmer by turning a button in the wall. In its optical properties this light is much like gas. It is yellow, steady, and soft, and consequently not irritating to the eye. It has none of the blue rays incident to the voltaic arc arrangement, and the shadow cast by intervening objects is softened and mellowed at the margin. For practical purposes it is intended that the power of each lamp shall not exceed that of two ordinary gas jets."

[It is stated that seven lamps are operated upon one circuit worked by four horse-power. The economy of this system does not appear to be marvellously great. Seven lamps of 27½ standard candles each, or 192½ candles in all, for four horse-power, is not a very wonderful achievement.—Ed. Tel. Jour.]

Review.

Instructions for Testing Telegraph Lines, and the Technical Arrangement of Offices. By Louis Schwendler. Vol. II. London: Trübner & Co., Ludgate Hill.

The object of this second volume of testing instructions is the supply of testing information to the officers in charge of telegraph stations where the testing has to be made with less elaborate instruments than the Wheatstone bridge or Differential galvanometer, the use and theory of which were explained in the first volume. The instrument employed for the comparatively simple system of testing is a tangent galvanometer, provided with accessories in the shape of a few resistance coils, a switch, &c. The instrument has three distinct deflecting coils, viz., a thick brass ring, which is used for measuring so-called "quantity" currents; a thick copper wire coil consisting of a few convolutions, having a total resistance of about one ohm; and a third coil formed of a large number of convolutions of thin wire, having a total resistance of about 100 ohms. In connection with the thin wire coil are three resistances of 100, 1000, and 2,000 ohms respectively, which can be put in circuit in the ordinary way by means of plugs, when required. The thick wire coil has also three resistances in connection with it, of 1, 20, and 200 ohms respectively.

In describing the instrument, Mr. Schwendler explains a fact, which, we believe, was first pointed out and proved by Mr. H. R. Kempe in the number of this Journal for July 1st, 1877, viz., that the tangent galvanometer is most sensitive when its deflection is equal to 45°.

As regards the accuracy with which a test can be made, Mr. Schwendler draws attention to a point which is almost obvious, but one which, as far as we are aware, has never been put in print before, namely, that in measuring a resistance with the tangent galvanometer by the simple device of observing two deflections with different known resistances in the circuit, it is very essential that the values of the known resistances should be in proportion to the value of the resistance whose value is being measured. Thus, if we are measuring a resistance whose value we know to be a few ohms only, and we first take a deflection with, say 1,000 ohms in circuit, and then another deflection with 2,000 ohms in circuit, theoretically from these two measurements it is possible to determine the exact value of the unknown resistance by a simple formula, but, practically, we may make an error of several hundred per cent., simply because the small unknown resistance has practically no influence upon the measurements

made, it being swamped as it were by the larger resistances in the circuit. We know many instances in which the want of an intelligent appreciation of the simplest tests leads to most absurd results being obtained; thus, for instance, a very common test for the resistance of a battery is that of joining the latter in circuit with a resistance coil and a tangent galvanometer, noting the deflection, then increasing the resistance until the deflection representing half the current is obtained, when the resistance of the battery x is obtained from the simple formula

$$x = \text{R} - (2\,r + g)$$

where r is the resistance when the first deflection is observed, R the resistance necessary to halve the current, and g the resistance of the galvanometer.

In measuring the resistance of a battery whose resistance is but 1 or 2 ohms by this method, an unintelligent experimenter is as likely as not to measure his deflections with several hundred, or even several thousand ohms in circuit, and then, on working out the result by the formula, he is surprised to find that the result he obtains is either several hundred per cent. higher than the resistance can possibly be, or the result he obtains has a negative value.

Mr. Schwendler truly remarks that, "Results obtained by experiment have scarcely any real signification, if the tester himself does not adopt some means of checking their accuracy."

In dealing with the questions of accuracy of measurement, the subject has been treated with great advantage by simple reasoning, without any elaborate mathematical proofs.

The chapter on Batteries is very full and exhaustive, though dealing only with the kind in use in India, viz., the Minotto. The number of cells of this kind in use in that country is over 10,000.

Mr. Schwendler makes a remark with reference to the testing of batteries, but which applies to all testing, which has a very great deal of truth in it, viz., that "Instead of testing being considered as a means of arriving at practical results, it has been regarded as the work itself, and as entailing no benefits whatsoever. If testing be executed with so little physical spirit and true understanding of its purposes, it would be better to dispense with it altogether."

Besides the testing of lines and batteries, every instrument used should be tested to see that it will satisfy the ordinary working conditions. The "Range test" to which the Indian instruments are subjected is for the purpose of determining the relative values of the weakest and strongest currents with which an instrument will work without the given adjustment of the latter being required to be altered. The range being a decreasing function of the speed with which the instrument is worked; the working range is that required at the greatest key speed. The range required in the Indian relays is found to be equal to four, as the working currents never exceed 8 milliwebers, and the relay will not work safely with less than 2 milliwebers.

A form of relay is described, the invention of M. D'Arlincourt, which is used successfully in India; but its advantages are by no means obvious. That it should be successfully worked is hardly a sufficient recommendation for its use, but if it exceeds in sensitiveness and reliability the existing forms of relays its advantage is clear; but we are inclined to think that this has not been proved, as the gain in one direction is neutralised by a corresponding loss in another, and thus, although the D'Arlincourt Relay possesses decided *novelty*, it does not possess decided practical advantages over existing forms of relays. Inventors seem continually to forget that something more than novelty is required in new inventions.

In the portion of the work dealing with the "Charge and Discharge of Telegraph Lines" several ingenious arrangements are explained for effecting this object in working long lines. The effect of the discharge in such lines is stated to be severely felt in India; but in America, where we fancy equally long lines are worked, we are not aware of any such discharging arrangements being used or considered necessary.

The action of electro-magnetic shunts is well understood and as easily comprehensible, but contrary to what might be expected, it has been found by Mr. Schwendler that a condenser placed in the same position as an electro-magnetic shunt effects the same object, though one would think that a reverse action would take place.

The reading instruments in use in India are the sounder and the ink-writer, the latter form of instrument as manufactured by Messrs. Siemens is so fitted that a broken mainspring can be replaced with great ease, there being no occasion for taking the whole instrument to pieces.

A great point in Mr. Schwendler's second volume of his testing instructions is, that it contains little else than thoroughly practical and useful matter, which was hardly the case with his first volume. Taking the two volumes as a whole they are very creditable productions, and should certainly be added to every electrician's library. They are more especially useful for those engaged in the Indian Telegraph Service, indeed, if they are to be regarded as instructions for general use in other services we are afraid that they will not prove of much value, and it is a pity that Mr. Schwendler did not make himself better acquainted with the real wants of other telegraph administrations before offering his work as a supply to this want. He would have done better if he had issued his work without recommending it for this purpose.

Correspondence.

To the Editor of The Telegraphic Journal.

Sir,—In a recent number of *Engineering*, Mr. Ladd claims for the "Brush" system of electric light "absolute steadiness." As invited by him, a scientific friend and myself visited the Great Eastern Station the other evening, and we were much disappointed to find anything but a *steady* light, one also producing a very unpleasant and ghastly illumination. The globes surrounding the light showed on one side a space covering one-third of the periphery, of a dirty brown colour, caused, very likely, by the shadow of the carbons or regulators. To our mind the station was

lit far better by gas; the height at which the lamps were hung counteracting any good effect a brighter light might have given. I *make* these observations simply because Mr. Ladd must understand that many who know some little regarding the various systems are not quite so much satisfied with the "Brush" as he is, nor think it "sweeps clean."

The "Lontin" lights at the Aldersgate Street Station I visited the same evening, and though by no means steady, were more so than those at Liverpool Street, and gave a brighter and clearer light, with none of that greenish sickly pallor experienced in the "Brush" system.

Yours, obediently,
ELECTRON.

Junior Carlton Club, Pall Mall.
April 5th, 1880.

AN AMERICAN OPERATOR.—The standard of insulation of the Postal Telegraph Lines in England is 200,000 ohms per mile in bad weather; if the insulation falls below this standard the line is considered faulty. This standard applies to all the lines worked by the Postal Department, and except in special cases where the lines run through a very smoky manufacturing district there is no difficulty in keeping it up. The *average* insulation of a line is greatly in excess of 200,000 ohms per mile, but no general average can be given, as it varies with the districts through which the lines run.—ED. TELEGRAPHIC JOURNAL.

Proceedings of Societies.

PHYSICAL SOCIETY.—APRIL 10th.

PROF. FULLER in the Chair.

New members—Mr. W. O. SMITH, Prof. JUDD, F.R.S.

A paper on "The Human Eye as an Automatic Photometer," by Mr. WILLIAM ACKROYD, F.C.S., was read. It is difficult to get the value of a very intense light in terms of a weak one, because the relative physiological values of the similarly coloured constituents are unknown. The author's experiments were made to show that the eye itself is a fairly good light measurer. When a "spot" or star of light is looked at from a distance it is seen to emit "rays" or spots of light at all angles. These are due to the structure of the crystalline lens and the lachrymal fluid on the surface of the cornea of the eye. The rays are of various lengths, and are shorter in the first and second quadrants near the blind spots next the nose than on the third and fourth quadrants, a fact probably due to the insensibility of this region. The iris expands and contracts under the stimulus of light independently of the will; and both ires act sympathetically. Now the iris lies between the seats of irregular refraction, and thus any change in the size of the pupillary aperture will be rendered evident by an alteration in the length of the longer rays of a spot or point of light. On this fact is based the use of the eye as an automatic photometer. The sensitiveness of the iris varies in different persons. The author finds that a sperm candle burning 120 grains per hour produces a distinct movement of his iris when fourteen yards distant. In employing the eye as a photometer the author adopts the principle that if the light from one source, A, falling on the eye is capable of producing movement of the iris at a distance, d, and the light from a different source, B, is capable of producing the same movement at the distance d', then the relative intensities can be formed from the inverse squares of these distances. To carry this out in practice the observer is in the dark, and an artificial star is placed on a level with the eyes at a fixed distance. Below this is placed the light to be tested in the same plane. While gazing steadily at the star the other light is to be eclipsed and revealed, and the observer is to find a position where the revealing of the second light does not influence his iris, as shown by no apparent shortening of the rays of the star taking place. He then approaches gradually till a second position is reached where the revealing of the second light *does* produce a movement of the iris. The distance between these two positions, d, is measured. A third light is now put in place of the second, and the same observations repeated so as to get a second distance, d'. From these distances the relative intensities are calculated. The author's results agree pretty closely with Rumford's photometer; but he found that for some reason the two first observations have to be discarded as too inaccurate. Owing to the sympathy between the two ires these experiments were binocular. This sympathy may prove convenient in constructing an eye-photometer, since one eye can be turned to the light to be estimated while the other is looking at the artificial star. This method of photometry would be too delicate for comparing powerful electric lights unless aided by mechanical means.

Prof. AYRTON then offered an explanation of the experiment shown by Prof. Guthrie at last meeting to the effect that, while flannel rubbed with ebonite was + electrified, and ebonite rubbed with glass was +, flannel rubbed with glass was —.

Prof. AYRTON accounted for this apparent anomaly on the grounds that one or more of the substances was an electrolyte. Glass, for instance, is an electrolyte, and a battery had been made from it. Experiments made by Prof. Perry and himself had shown that in a "pile" made up of divers substances, one or more of which were electrolytes though the rest were metals, the electro-motive force of the pile was equivalent to the algebraical sum of the several "pairs" composing it, but it was *not* equivalent to the electro-motive force of the first and final plates made into a pair. That could not be predicted from the contact electro-motive forces of the elementary pairs. When only metals were employed it could, but not in cases where an electrolyte entered. This same result would apply to Professor Guthrie's frictional experiments.

In answer to Prof. Guthrie's question, whether electrolysis did not come into play in Prof. Ayrton's experiments, Prof. AYRTON replied that it could not operate to a greater extent than in Prof. Guthrie's experiments, as he had used a quadrant electrometer.

Dr. STONE then described a new tonometer devised by Prof. Rudolf König, which he had recently seen in Paris. It consisted of a clockwork working into a tuning-fork which produced no less than 128 escapes per second. To this clockwork, originally invented by an assistant of M. Breguet, and exhibited at the Paris Exhibition of 1856, Prof. König had added a Helmholtz vibration microscope, moved by the clock, and the fork whose vibration number is to be measured is placed vertically in the focus of the microscope. The apparatus is very portable, and no loading of the fork is required.

Prof. HUGHES observed that he had patented a vibrating regulator in 1856.

Dr. GUTHRIE then exhibited an electric machine formed of a collodion disc rubbed with cat's fur and giving negative sparks. The collodion, after a suggestion of Captain Abney, was put on by giving a disc

a coat of collodion, then a coat of india-rubber dissolved in benzol, then a coat of collodion again. Prof. GUTHRIE also showed that an iron cylinder revolving round its longer axis with a current flowing in a wire parallel to it has power to deflect a magnetic needle. Prof. AYRTON stated that he had found the mere rotation of an iron cylinder produce the deflection in question, and therefore thought the current was not required to produce the effect shown.

New Patents—1880.

1286. "Telephones." J. H. JOHNSON. (Communicated by E. Marx, F. Aklem, J. Kayzer, and L. Davis.) Dated March 27.

1295. "Insulating electrical conductors." E. M. ALLEN. (Communicated by A. A. Knudson and F. L. Kane.) Dated March 30.

1328. "Improvements in and relating to telegraphic and telephonic apparatus." W. R. LAKE. (Communicated by E. Davis and P. A. Dowd.) Dated March 31.

1333. "Improvements in or applicable to machinery or apparatus for the manufacture of engine-packing, insulated telegraph wires, or other similar manufactures." G. F. JAMES. Dated March 31.

1339. "A new or improved rotary induction or electric motor." J. C. MEWBURN. (Communicated by W. de Fonvielle.) Dated April 1.

1343. "Improvements in apparatus for the production and application of electricity and of magnetism." J. L. PULVERMACHER. Dated April 1.

1385. "Dynamo-magneto electric machines and electric motors." T. A. EDISON. Dated April 5.

1392. "Improvements in and relating to dynamo-electric machines." W. R. LAKE. (Communicated by H. S. Maxim.) Dated April 5.

1397. "Improvements in electric lamps and in solenoids applicable for their regulation." C. D. ABEL. (Communicated by F. Krizik and L. Piette.) Dated April 6.

1407. "Improvements in electrical conductors and in the arrangement and manner of using conductors for telephonic and telegraphic purposes." O. HEAVISIDE. Dated April 6.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

3164. "Demagnetising iron ships to prevent deviation of the compass." EVAN HENRY HOPKINS. Dated August 6. 6d. Consists in passing a straight powerful permanent magnet, or an electro magnet, held more or less in the angle of the magnetic dip, over the transverse beams supporting the decks. The magnet is passed either from the sides to the centre of the deck, or from the centre to the sides, or from one side to the other, according to the magnetic conditions of the iron to be operated upon.

3207. "Apparatus for reversing electric currents." W. R. LAKE. (Communicated by Count Emile Siccardi.) Dated August 9. 8d. Has for its object a current reversing apparatus or manipulator for use in submarine telegraphy and with cables of any length or resistance. It may also be employed with the devices known as the siphon recorder or the receiving mirror of Sir W. Thomson. Its special purpose is to render the signals always perfectly clear upon these instruments by a constant reversal of current.

3355. "Manufacture of electrodes for the electric light." W. MORGAN-BROWN. (Communicated by Paul Albert Porlier.) Dated August 20. 6d. Consists in replacing carbon electrodes and electrodes with metallic cores by electrodes of an external metallic tube, the combustion of which is slackened by a substance charged within the tube and which is capable of forming with the metal of the tube a combination which is a bad conductor of electricity, and which is constantly reproduced under the influence of the electric current at the same ratio at which it is consumed by the same current. Amongst other substances are named oxide of magnesia, dolomite, or carbonates of magnesia, of lime, and even of baryta and of strontium.

3393. "Telephones." PHILIP SYNGE JUSTICE. Dated August 23. 6d. Consists in holding by mechanism the carbon or other imperfectly conducting medium in the transmitting instrument regularly under pressure, and in causing the action of the diaphragm, under the impulses of the sound-waves, to diminish the pressure thus regularly applied, whereby the resistance of the carbon or other conductor can be reduced and regulated at will, and greater sensitiveness and scope of the electrical indulations produced; and also consists in causing the vibrations of the diaphragm to act through intermediate mechanism, whereby the motion of the said diaphragm is exaggerated and greater effect produced upon the carbon or other medium.

3472. "Compounds for insulating telegraph wires." ALEXANDER WILKINSON. Dated August 28. 4d. Relates to improved compounds or combination of ingredients for insulating and coating telegraph wires, and consists, first, in amalgamating one pound of bees-wax, three pounds of white lead, with a proportion of Stockholm tar, and a small quantity of tallow. Second, in repeating this operation. Third, in a plaiting or braiding operation; and, fourth, in passing it through a compound of pitch, ground cork, and bisulphite of carbon, mixed in suitable proportion and brought into a liquid form without heat.

3543. "Electro-magnetic induction apparatus." ROBERT HENLADE COURTENAY. Dated September 3. 2d. Consists of four soft iron or soft steel bars, arranged in a square, so that the ends are respectively in as close proximity to each other as is possible without actual contact. Upon each bar are mounted two or more bobbins, having each two or more primary and two or more secondary coils, the coils being wound in such a direction as to give the necessary polarity to the iron cores. From this arrangement it will be seen that on making and breaking contact with a voltaic battery in circuit with the primary coils of all the bobbins powerful induction will take place at each end of the iron cores, inducing currents in the secondary coils as though these were being excited by a rotating armature driven by a separate source of power. (*Provisional only.*)

City Notes.

Old Broad Street, April 14th, 1880.

DIRECT SPANISH TELEGRAPH COMPANY.—The half-yearly general meeting of this Company was held on Wednesday, the 31st ult., at the offices, Cannon Street. Mr. Neil Bannatyne presided, and, in moving the adoption of the report (an abstract of which appeared

in our last issue), said that everything connected with their revenue went on very favourably till close on the end of the year. In October a fault was discovered in their cable, but it was repaired, and it caused no interruption in their traffic; but at the end of December they received telegraphic information that the Bilbao cable had broken down. It occurred at a most unfortunate period, and the repair was rendered a very difficult task owing to the bad weather. The repair had, however, been effected, and the electrical condition of the cable was now as perfect as ever. He was happy to inform them that since they resumed work their traffic had come back to them, and their receipts had been highly satisfactory since. There had also been an improvement on the Marseilles and Barcelona cable. He expressed the regret of the board that they could not recommend a dividend either on the preference or ordinary shares, owing to the cost of the repair of the cable. Although their receipts for the half-year had shown such a considerable increase the expenses remained at what they regarded as the normal figure. He then referred to the great development of the Bilbao traffic since the revival in the iron trade. The word-rate system would come into operation immediately, and he hoped, as in the cases where it had already been adopted, their receipts would be beneficially affected by the change. In reply to a question, the Chairman said he believed the balance of profit and loss account, £2,200, and the reserve fund of £4,450, would more than suffice for the cost of the repair of the cable. The report was adopted.

Indo-European Telegraph Company.—The ordinary general meeting of this Company was held at the Cannon Street Hotel on Wednesday, the 31st ult. Colonel James Holland was in the chair, and, in submitting for approval the report and accounts of the year 1879, he stated that the Company was in the predicament in which countries were said to be happiest—viz., when they had no history. They had been carrying on their work during the past year in a fairly prosperous condition—not by leaps and bounds, making large sums of money, but by continuing fairly well the reasonable progress they made the year before. In that year they made the largest income they had ever before realised, and this last year they had exceeded that by about £1,100, while the turn-out generally would have been still better than it had been but for what very often happened in the course of events—a few exceptional cases, in which, however, there was nothing of the slightest importance as materially affecting the Company's interests. The expenditure had been only a little in excess of that of the previous year, and the excess had been incurred for necessary and beneficial objects, which included the acquisition of property for building of new offices. Up to the end of last month the only debt owing to the Company upon any of the accounts was one of a few hundred pounds, which was due from the Indian Government, and was therefore considered perfectly safe. A sum between £2,500 and £2,600 had been paid to Messrs. Siemens in formal settlement of a debt connected with various affairs in Persia. With regard to the meeting of the International Telegraph Conference in London last year, the Chairman said it had settled telegraph affairs for the next five years, the next meeting having been appointed to be held at Berlin in 1884; and he believed that most parties, especially the mercantile community, would be glad that it was so. The Company had no reason to complain of what was done at that conference; because, although their own interests were not specially considered, they regarded the results as being reasonable and fair to all parties. The Company had not yet succeeded in obtaining from the Russian Government a decision upon their claims on account of the destruction of some 60 or 70 miles of telegraph during the Russo-Turkish war, but the matter was still under discussion, and the Company looked to the Russian Government to do what was right. The Chairman concluded by moving that the report, the substance of which has already been published, and the accounts should be received and adopted. The motion was seconded by Mr. W. H. Barlow. Mr. Ford asked whether the directors would not think it desirable to have half-yearly instead of only yearly meetings. He was of opinion himself that they ought to be half-yearly. Mr. Beard took the same view. Mr. Hofner was opposed to half-yearly meetings, but recommended a monthly or weekly publication of the accounts. The Chairman said the directors would offer no objection to half-yearly meetings if any general desire was expressed on the part of the shareholders in that direction, but he did not understand that any such feeling was generally entertained. To the monthly or weekly publication of the accounts there were various objections, and he did not think the shareholders generally would be in favour of that course. Mr. Ford was opposed to the monthly or weekly publication of the accounts. The motion for the adoption of the report was unanimously agreed to, and a dividend of 6 per cent. was declared for the year. The retiring directors, General Tremenheere, and Messrs. Tritton and Weaver, were re-elected, and Messrs. Kemp, Ford, and Company were reappointed auditors. The proceedings then closed with a vote of thanks to the chairman.

The Great Northern Telegraph Company's working account for the year 1879 shows that the traffic receipts from the stations in Europe amounted to £89,748 1s. 11d.; and from those in China and Japan to £114,295 10s. 11d., making a total of £204,043 12s. 10d. Interim dividends amounting to 5 per cent. have already been paid, and an extra dividend of 2s. 9d. per share is now notified, leaving, after additions to the reserve, renewal, and pension funds, and the payment to the directors, a balance to be carried forward of £16,242 7s. 4d.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.—The report of the directors for the six months ended 31st December, 1879, to be presented at the thirteenth ordinary general meeting of the Company, to be held at the City Terminus Hotel, Cannon-street, on Wednesday, the 21st day of April, 1880, at two o'clock, states that the total receipts for that period have amounted to £165,930 11s. 2d., against £140,976 11s. 1d. for the corresponding half-year of 1878, giving an increase of £24,954 0s. 1d. The working and other expenses (including a sum of £22,864 5s. 3d. for cost of repairs and renewals of cables and expenses of ships), together with interest on debentures and income tax, absorb £68,683 6s. 3d., leaving a balance of £97,247 4s. 11d. as the net profit for the half-year, which, with £34,660 6s. 9d. brought forward from the previous half-year, makes a total of £131,907 11s. 8d. to be dealt with. One interim dividend of 1¼ per cent., amounting to £24,968 15s., has been paid for the half-year, and it is now proposed to distribute another of similar amount payable on the 22nd April, making, with the two interim dividends paid for the first half-year, a total distribution of 5 per cent. for the year 1879. The balance, amounting to £81,970 1s. 8d., has been carried to the reserve fund, which now stands at £157,870 17s. 6d. Having regard to the extension of the Company's cables, the directors desire that the reserve fund should accumulate to an amount proportionate to the capital, and sufficient to guarantee the

stability of the Company's system. The directors have to announce that the remaining section of the duplicate Australian cable, viz., between Singapore, Java and Australia, was successfully laid on the 29th January, or a month within the time fixed by the contract with the Australian Governments for the completion of the work. The alterations in the Manila concession referred to by the chairman at the last general meeting having been obtained from the Spanish Government, a contract has been entered into by the Company with the Telegraph Construction and Maintenance Company for carrying out its provisions. The whole of the cable has been manufactured and shipped, and is now on its way to Manila. The work is expected to be fully completed in the course of the next month. All the cables of the Company continue to work satisfactorily. In accordance with Article 13 of the Articles of Association, Mr. F. A. Bevan, Mr. C. W. Earle, and Baron d'Erlanger retire by rotation. The two former being eligible, offer themselves for re-election. Baron d'Erlanger does not offer himself for re-election. The retiring auditors, Mr. Henry Dever and Messrs. Quilter, Ball & Co., offer themselves for re-election.

The Direct United States Cable Company, Limited, notify that the Interim Coupon for interest to 15th April, on their 6 per cent. Debenture Loan, will be paid on and after that date at the Consolidated Bank, 52, Threadneedle Street, London, E.C.

We gather from the last administration report of the Indo-European Telegraph Department for 1878-9 that the net revenue of the year amounted to £7,328, a decided improvement on the previous year's working, when there was a net loss of £40,182, the length of lines working being the same in both years. The director, Lieut-Colonel J. U. Bateman-Champain, R.E., considers that these figures show as favourable a state of working as can reasonably be expected. In the Persian Gulf on several occasions the cables were interrupted, but the cable and land line were never simultaneously stopped. The distance between London and Teheran is 3,800 miles; the average time of transit of all messages is given as 17min. 30sec.; while the time occupied in transmitting messages between Teheran and Bushire is stated at 2min. 58sec. In all about 35,000 messages, comprising 700,000 words, were sent; of these 32,000 were through messages between Europe and India and the far East.

The coupons of the Submarine Cables Trust, due on 15th inst., will, under authority of the Court, be paid, on and after that date, by Messrs. Glyn, Mills & Co.

The Globe Telegraph and Trust Company (Limited) notify that interim dividends for the quarter ending 18th inst. of 3s. per share on the Preference Shares, being at the rate of 6 per cent. per annum, and 2s. per share on the Ordinary Shares, at the rate of 4 per cent. per annum, both free of income-tax, will be paid after the 20th instant.

The opening of telegraphic communication by "La Compagnie Française" between England and the States is still delayed, the shore end of the cable from Brest to Penzance not being yet put down.

The following are the final quotations of telegraphs:—Anglo-American, Limited, 58¾-59¼; Ditto, Preferred, 88½-89½; Ditto, Deferred, 33-33⅜; Brazilian Submarine, Limited, 7⅝-7⅞; Cuba, Limited, 9½-10; Cuba, Limited, 10 per cent. Preference, 16¼-16¾; Direct Spanish, Limited, 2-2⅜; Direct Spanish, 10 per cent. Preference, 10⅜-11; Direct United States Cable, Limited, 1877, 11-11¼; Scrip of Debentures, 100-102; Ditto, £25 paid, par-2 pm.; Eastern, Limited, 9-9¼; Eastern 6 per cent. Preference, 12⅜-12⅞; Eastern, 6 per cent. Debentures, repayable October, 1883, 104-107; Eastern 5 per cent. Debentures, repayable August, 1878, 101-103; Eastern, 5 per cent., repayable Aug., 1899, 101-103; Eastern Extension, Australasian and China, Limited, 8⅞-9⅛; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 100-102; Ditto, registered, repayable 1900, 101-103; German Union Telegraph and Trust, 8¾-9¼; Globe Telegraph and Trust, Limited, 5⅝-5⅞; Globe, 6 per cent. Preference, 11⅝-11⅞; Great Northern, 9⅝-9⅞; Indo-European, Limited, 24-25; London Platino-Brazilian, Limited, 4⅜-5; Mediterranean Extension, Limited, 3-3⅜; Mediterranean Extension, 8 per cent. Preference, 10⅜-11⅜; Reuter's Limited, 10-11; Submarine, 230-240; Submarine Scrip, 2-2¼; West Coast of America, Limited, 2⅛-2⅝; West India and Panama, Limited, 1⅝-1⅞; Ditto, 6 per cent. First Preference, 7⅜-8; Ditto, ditto, Second Preference, 7-7⅜; Western and Brazilian, Limited, 7-7¼; Ditto, 6 per cent. Debentures "A," 100-103, Ditto, ditto, ditto, "B," 100-103; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 33½-34; Ditto, 6 per cent. Bonds, 104-108; Ditto, Second Bonus Trust Certificates, 3-3¼; India Rubber Co., 14¾-15¼; Ditto, 6 per cent. Debenture, 103-105.

New Anglo-American Cables.—In reply to a message from President Green, of the Western Union Telegraph Company, inquiring whether the Anglo-American Telegraph Company are likely to lay another cable during the coming summer to meet the largely increased business, Mr. Weaver, the general manager, replied as follows:—"Yes, I am now negotiating the contract for two cables—one from Valentia to Heart's Content, with a new form of outer covering for its better protection in deep sea, and the second from Placentia to Sydney, touching at St. Pierre, containing at least three conducting wires, with an exceptionally heavy outer covering, weighing seven tons per knot, and the shore ends of a heavier type. I think you will do well to put up another wire at least. I should have thought two more would be required." Dr. Norvin Green answered as follows:—"The additional wire proposed will be of No. 4 gauge, and worked quadruplex."—*Journal of the Telegraph.*

The Brush machines and lamps for use in England are henceforth to be manufactured at the telegraph works of W. T. Henley & Co., Limited.

The *Magnet* facetiously remarks that, when Mr. Edison was last heard of, he was searching for his electric light by the aid of a tallow candle.

A Wonderful Invention—Electricity Stored in Tanks till Wanted.—"The machine for this purpose consists of an electro-dynamic machine, driven by a powerful engine. A second apparatus, called the electrometer, or reservoir, is used in connection with the dynamic machine. This consists in huge Leyden jars, or tanks, resembling those used in the manufacture of gas. These are 55 feet in diameter and 22 feet in height. The cover is movable, and has a weight of over nine tons. The electricity is manufactured in the machine, and is forced into the electrometers at the bottom. This causes the lid to rise until the space inside is filled with electricity. By using a sufficient quantity of these electrometers, enough electricity can be stored up to last the company a year, thus doing away with the constant use of the engine. The electrometer is tapped at the bottom and the wires inserted. A constant stream of electricity flows over the wire as the lids press equally on it by its enormous pressure." The above it is, perhaps, unnecessary to say is from America.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 174.

SEEING BY ELECTRICITY.

SOME excitement has been created in the electrical world by the report that a sealed packet, containing the account of an invention, has been deposited by the inventor of the Bell telephone. The report states that the invention is one for "seeing by electric telegraphy." What the nature of the invention is, remains, as yet, a mystery; but, in the mean time, attempts are being made to snatch the credit of the invention or discovery from the possible true inventor's hands. A letter has recently been circulated by some well-known scientific gentlemen, to the effect that whatever may be the means by which Professor Bell effects the object he is supposed to have in view, that object has already been practically worked out. The argument contained in the letter in question seems to us to be of the flimsiest possible description; and to say that to the discoverer of the effect of light upon the electrical resistance of selenium really belongs the credit of having solved the question of seeing by electricity, is equivalent to assigning to Faraday the credit of having invented the telephone. The idea put forward as furnishing a solution of the problem is as far from the practical solution as can well be imagined, and the attempt to claim credit at the expense of future real inventors, is, in our opinion, decidedly contemptible, and we must express our surprise at the spirit which could have prompted such an act.

As regards the general question of seeing by electricity, the principles involved are somewhat different from those which have entered into other electro-telegraphic problems; the element of *time*, which plays such an important part in all telegraphic inventions hitherto brought out, is almost wholly absent when the question of sight is involved. In the transmission of sound, or of telegraphic signals by electricity, we have to cause a succession of signals to follow one after the other, and hence it follows that a single telegraphic wire is able to effect all that is required. In the case of *seeing*, in order to enable the form and colour of an object to be rendered evident to the senses, it is necessary that a series of impressions, infinite in variety, be produced upon the retina in an almost immeasurably short space of time, and, practically, all at the same instant; we must have, in fact, an infinite series of waves transmitted at the same, or nearly the same, moment. To do this through a single wire by electrical means is a difficult problem; but that it will eventually be done by means of a single wire, is, we think, an undoubted fact. How it is to be done is another question; but we feel certain that no arrangement involving a multiplicity of wires will ever enable success in the direction aimed at to be attained. It is not because a multiplicity of wires is objectionable for practical telegraphic purposes that we say this; but, because, almost without exception, all complete solutions of problems, like that of the telephone, for example, have been most completely and thoroughly effected by the simplest means.

ON MAGNETIC CIRCUITS IN DYNAMO AND MAGNETO-ELECTRIC MACHINES.*

By LORD ELPHINSTONE and CHARLES W. VINCENT, F.R.S.E., F.C.S., F.I.C.

Communicated by Professor G. G. STOKES, Sec. R.S.

(Continued from page 136.)

IN the course of these experiments it was remarked, that the longer the period the soft iron remained in close magnetic circuit the more magnetically ductile did its molecules appear to become. An electro-magnet, which had been for a few days in closed circuit, could, after rupture of the circuit, be made to sustain weights in a fresh closed circuit at much shorter intervals of time than if it was magnetised, after being for some time with its poles uncovered. The direction of the battery current with reference to the residual magnetism of the electro-magnets appeared to be of no moment. A magnet which had been left for some time with its poles uncovered had less residual magnetism after a momentary current had passed through its helices than another magnet which had been in active closed circuit, even if the battery current had, in the latter case, to overcome a considerable amount of residual magnetism.

We found, moreover, that soft iron magnets retain their residual magnetism longer, and are capable of acquiring increased magnetisation much more rapidly after having been bearing weights (thereby keeping the iron in a state of strain), than if they have been left in their normal condition and without bearing any weight at all.

The conditions under which the closed magnetic circuit retains its force are not yet clearly established.

With the 58 lb. magnet a succession of gentle taps, struck vertically with a wooden mallet upon the centre of the armature, while resting on the magnet in close circuit, in a very few moments completely dissipated the magnetic force, so far as the sustaining power of the magnet was concerned.

Removal of any portion of the weight suspended

* Read before the Royal Society.

to the armature of a magnet hung up in closed circuit likewise tends to dissipate the force of the circuit. For example:—Half an hour after the removal of a weight of 10 lbs., which had been suspended to the armature of a U magnet for twenty-one days, the armature fell off on receiving a slight touch. In another experiment, a U magnet, which was capable of sustaining 7 lbs., and which had actually been suspending 4 lbs., was left for two months with the armature on only, the weight having been removed; at the end of that time a very slight shake was sufficient to cause the armature to fall off. Many other examples might be quoted to show that release from a strain diminishes the magnetic force of the circuit.

In these experiments, in which the closed magnetic circuits had given way, the soft iron had been in a state of strain from which it had been released by the removal of the suspended weights. But when no weights were hung upon the armature, and the iron had never been in a state of magnetic tension, the closed magnetic circuit, so far from diminishing, increased in force. The 58 lb. magnet was excited with a voltaic current so feeble, that although the magnet could be lifted by the armature in closed circuit, yet great care was necessary that the lift should be exactly vertical; and very little force was required to slide the armature off the poles. After the lapse of a month the armature was so firmly held that the utmost exertion of manual force could not stir it by a sliding movement, and the whole magnet could be raised from the ground even if tilted as much as 15° from the perpendicular.

The magnetism of the closed circuit of the 58 lb. magnet disappears after repeated up and down movements of either one or both of its helices, provided the ends of the helix wires are connected together either singly in two separate circuits, or together in one continuous circuit. Every up or down movement of either of the helices produces currents in the wires either for or against magnetisation, which currents apparently so disturb the molecules of the iron that the fixity of their original magnetic direction is lost.

In like manner as the movements of the armature, or the increased or diminished tension of the iron, produce currents of electricity in the helix wires surrounding the magnets: so the movements of the helices produce currents of electricity in the helix wires surrounding the magnets: so the movements of the helices produce currents of electricity which may either magnetise or demagnetise the iron. With the 58 lb. magnet in closed circuit, the two ends of one of the helices being connected to the galvanometer, and the two ends of the other helix being connected with each other, the latter helix is moved towards the armature, a current is produced in the galvanometer helix, which shows a fall of magnetization. On moving the same helix away from the armature, a current is produced in the direction of magnetisation.

In another experiment 30 yards of No. 16 covered copper wire, with its ends connected together, and so coiled that it could be moved freely from pole to pole over the armature, was placed on one limb of the 58 lb. magnet and the closed circuit established. Both helices were then brought into continuous circuit through the galvanometer.

On movement of the coil of wire from south limb to the north limb of the magnet, a current was produced showing an increase of magnetisation. On moving the coil in the opposite direction, *i.e.*, over the north limb pole, and on to the south one, the current is reversed, and is in a direction which would cause demagnetisation.

It appears, therefore, that any interference with the lines of force about a magnetic circuit, means an interference with the magnetic circuit itself, and points to the possibility of building up magnetic force of magnets by the mere movement of wires in these lines of force, though the coils moved need not of necessity be connected with the helices surrounding the magnets.

A NEW ALTERNATING CURRENT DYNAMO-ELECTRIC MACHINE.

A DYNAMO-ELECTRIC machine, involving some novel points, has recently been invented by Mr. J. Rapieff. I, I, is an iron frame, to which is secured the metal frame, F, F; to the latter are fixed flat bobbins of wire A, A, somewhat similar to galvanometer coils. Within these bobbins, and occupying the same relative position to the needle of a galvanometer, are the flat bobbins, B, B, which contain soft iron cores, C, C; the latter are secured to an axle, *a*, *a*, by which they can be rotated. The ends of the coils, B, B, are con-

Fig. 1.

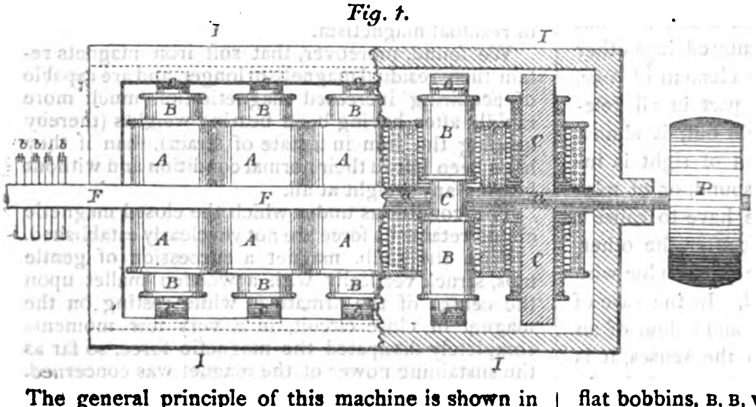
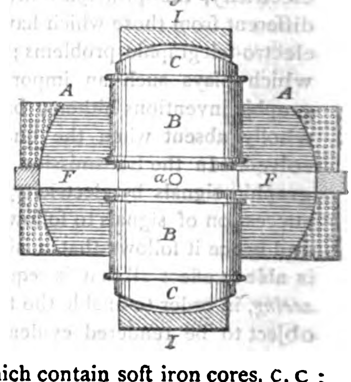


Fig. 2.



The general principle of this machine is shown in side and end elevation by figs. 1 and 2, the figs. being drawn partly in section.

nected to brushes, *b*, *b*, by means of which continuity can be kept up whilst the bobbins rotate. The wires from A, A are connected to terminals, in the ordinary manner. To work the machine, a permanent current is sent through the bobbins, B, B, which latter are kept continually rotating by the axle, *a*, on which is fixed the driving pulley, P. As the bobbins, B, B, and their soft iron cores, C, C, rotate within the bobbins, A, A, alternate currents are induced in the latter each time a half revolution is completed. The strength of these currents is increased by the action of the iron inductive armatures, I, I, which close the magnetic circuit of the core, C, C, each time the two come opposite one another; thus an effect is produced similar to that which would take place if the core, C, C, were alternately magnetised and demagnetised.

A great point in this machine consists in the fact that no commutator with brushes is required, a feature not possessed by other machines.

SOME ELECTRICAL MEASUREMENTS OF ONE OF MR. EDISON'S HORSESHOE LAMPS.

By HENRY MORTON, Ph. D., ALFRED M. MAYER, Ph. D., and B. F. THOMAS, A.M., at the Stevens Institute of Technology.

MUCH has been written and said within the last few months on the subject of Mr. Edison's new horseshoe lamps, and with all the writing and saying there has been wonderfully little produced in the way of precise and reliable statement concerning the simple primary facts, a knowledge of which would give the means of estimating both the scientific and commercial status of this widely discussed invention.

It was, therefore, with great pleasure that the present writers found themselves, through the kindness of the *Scientific American*, placed in possession of one of these horseshoe lamps of recent construction.

To satisfy themselves as to the real facts of the case, they soon made a series of careful measurements and determinations, and as the results of these are likely to interest others, they now put them in print for general benefit.

A further examination of other lamps would have been made at the same time had opportunity offered; but as a communication on this subject addressed to Mr. Edison did not evoke a reply, they are obliged to content themselves with the one lamp as a subject of experiment.

They would, however, here remark, that the behaviour of this lamp, under the tests, and the agreement of its results with information otherwise obtained, convince them that it is at least a fair specimen of the lamps of this form so far produced at Menlo Park.

The first object, on receiving the lamp, was to determine roughly what amount and character of electric current would be needed to operate it efficiently. With this view a number of cells of a small Grove's battery were set up, having each an active zinc surface of twenty square inches and a platinum surface of eighteen square inches.

The lamp being placed in the situation usually occupied by the standard burner in a Sugg's photometer, the battery was, cell by cell, thrown into circuit.

When ten cells had been introduced, the horseshoe showed a dull red, with fifteen cells a bright red, with thirty-four cells the light of 1 candle was given, with forty cells the light of 4½ candles, and with forty-five cells the light of 9¼ candles, and with forty-eight cells 16 candles.

Having thus determined what amount of electric current would be required for experiments, arrangements were made to measure accurately the resistance of horseshoe while in actual use and emitting different amounts of light. The resistance of this carbon thread at the ordinary temperature had been already determined as 123 ohms in the usual way, but it was presumed, as had been shown by Matthiessen (*Phil. Mag.*, xvi., 1858, pp. 220, 221), that this resistance would diminish with rise of temperature.

To measure the resistance under these circumstances the apparatus was arranged as follows:—The current from the battery was divided into two branches, which traversed, in opposite directions, the two equal coils of a differential galvanometer. One branch then traversed the lamp, while the other passed through a set of adjustible resistances composed of German-silver wires stretched in the free air of the laboratory, to avoid heating. (Careful tests of these resistances showed that no sensible heating occurred under these circumstances.)

Matters being thus arranged, the resistances were adjusted until the galvanometer showed no deflection when the candle power of the lamp was taken repeatedly in the photometer, and the amount of resistance was noted.

These measurements were several times repeated, shifting the coils of the galvanometer and reversing the direction of the current.

The results so obtained were as follows:—

Resistances.	Condition of Loop.
123 ohms.	Cold.
94 „	Orange light.
83·7 „	$\frac{9}{10}$ candle.
79·8 „	5 „
75 „	18 „

The photometric measurement was in all these cases taken with the carbon loop at right angles to the axis of the photometer, which was, of course, much in favour of the electric lamp. On turning the lamp round so as to bring the carbon loop with its plane parallel with the axis of the photometer, *i.e.*, the edge of the loop turned toward the photometer disc, the light was greatly diminished, so that it was reduced to almost one-third of what it was with the loop sideways to the photometer disc.

Having thus determined the resistance of the lamp when in actual use, it was next desirable to measure the quantity of the current flowing under the same conditions.

To do this the current from fifty cells of battery was passed through a tangent galvanometer as a mere check or indicator of variations, and then through a copper voltameter, *i.e.*, a jar containing solution of cupric sulphates with copper electrodes immersed, and then through the lamp, placed in the photometer.

Under these conditions it was found that during an hour the light gradually varied from about 16 candles at the beginning to about 14 candles at the end, making an average of about 15 candles, measured with side loop of toward disc.

The galvanometer during this time only showed a fall of half a degree in the deflection of the needle.

Carefully drying and weighing the copper electrodes, it was found that one had lost 1·0624 grammes.

Now it is well known that a current of one weber takes up 0·00326 gramme of copper per second, which would make 1·1736 grammes in an hour; therefore the current in the present case must have been on the average $\frac{1·0624}{1·1736} = 0·905$ weber, or a little less than one weber.

Having thus obtained the resistance of the lamp when emitting a light of 15 candles, namely, 76 ohms, and the amount of current passing under the same conditions, namely, 0·905 weber, we have all the experimental data required for the determination of the energy transformed or expended in the lamp, expressed in foot pounds. For this we multiply together the square of the current, the resistance, the constant 0·737335 (which expresses the fraction of a foot pound involved in a current of one weber traversing a resistance of one ohm for one second), and the number of seconds in a minute. Thus, in the present case, we have $0·905^2 = 0·8125$, and $0·8125 \times 76 \times 0·737335 \times 60 = 2753·76$ foot pounds.

Dividing these foot pounds per minute by the number of foot pounds per minute in a horse-power, that is, 33,000, we have 0·08, that is, about eight one-hundredths or one twelfth of a horse-power as the energy expended in each lamp.

It would thus appear that with such lamps as this, one horse-power of energy in the current would operate 12 lamps of the same resistance with an average candle-power of 10 candles each,* or 120 candles in the aggregate.

Assuming that a Siemens or Brush machine were employed to generate the electric current, such a current would be obtained, as has been shown by numerous experiments, with a loss of about 40 per cent. of the mechanical energy applied to the driving pulley of the machine. To operate these 12 lamps, therefore, we should have to apply more than one horse-power to the pulley of the machine, so that when this loss in transformation had been encountered there should be one horse-power of electric energy produced. This would call for 1⅔ horse-power applied to the pulley of the dynamo-electric machine by the steam engine.

To produce one horse-power in a steam engine of the best construction about 3 lbs. of coal per hour must be burned, and therefore for 1⅔ horse-power 5 lbs. of coal must be burned.

On the other hand 1 lb. of gas coal will produce five cubic feet of gas, and will leave, besides, a large part of its weight in coke, to say nothing of other "residuals," which will represent practically about the difference in value between "steam making" and "gas making coal," so that it will not be unfair to take 5 lbs. of gas coal as the equivalent of 5 lbs. of steam coal.

These 5lbs. of gas coal will then yield 25 cubic feet of gas, which, if burned in five gas burners of the best construction, will give from 20 to 22 candles each, or 100 to 110 candles in the aggregate.

We have, then, the twelve Edison lamps producing 120 candles and the five gas burners producing 100 to 110 candles, with an equivalent expenditure of fuel.

If each apparatus and system could be worked with equal facility and economy, this would, of course, show *something* in favour of the electric light; but when in fact everything in this regard is against the electric light, which demands vastly more machinery, and that of a more delicate kind, requires more skilful management, shows more liability to disarrangement and waste, and presents an utter lack of the storage capacity which secures such a vast efficiency, convenience, and economy in gas, then we see that this relatively trifling economy disappears or ceases to have any controlling importance in the practical relations of the subject.—*Scientific American.*

* The candle power being 15 candles in the best position, and 5 candles at right angles to this, the average or general illuminating power of the lamp is 10 candles.

ON THE MECHANICAL TRANSMISSION OF SOUND BY WIRES, AND ON SIMPLE FORMS OF MICROPHONE RECEIVERS.

By W. J. MILLAR, C.E., Sec. Inst. Engineers and Shipbuilders in Scotland.

The object of the present paper is the description of a series of experiments made by the author upon the transmission of sounds by wires without the aid of electricity, and also the description of some simple forms of microphone receivers, which the author has from time to time arranged when experimenting upon electric transmission of sound.

The author's attention had for some time been drawn to the consideration of the mechanical transmission of sound through partition-walls between rooms, and it appeared to him that such transmission might be possible, even although the intermediate connection was much extended.

Some experiments were made with wires, which were at first unsuccessful on account of the proximity of the speaker and hearer, and from not having suitable terminations to the line of wire used.

Further experiments, however, showed that, when the ends of the wire were sufficiently far apart, and by using as terminals simple pasteboard discs, or boxes, no difficulty was experienced in transmitting vocal sounds.

Various experiments were afterwards made from time to time. These experiments were repeated under various conditions as to distance, nature of wire used, and forms and quality of terminal mouth and ear-pieces. To enumerate some of the more important experiments :—

1st. About 20 yards of No. 40 copper wire were carried from house to outside, when speaking, singing, breathing, and musical sounds were easily transmitted.

This experiment was arranged in various ways. In the first trial the wire was kept free from touching

any intermediate substance, and was kept in a moderate state of tension by the holders of the pasteboard discs used at either end. Afterwards it was found that, with suitable arrangements, the wire could be led from room to room, thus passing round corners, and that several persons could be in communication at the same time by simply joining on other terminals to the main wire.

2nd. Several yards of No. 23 copper wire were carried from one room through an adjoining one and to a room beyond, the *wire rested on the carpet*, and was simply tightened a little at each end, and fastened to the floor with a carpet tack. Two attachments were then made of a similar-sized wire, and the doors leading to the rooms in connection were *closed above* the wire.

Conversation, musical, and other sounds were then readily transmitted.

In some after experiments, No. 16 copper wire was found to give better results.

Another and somewhat similarly-arranged experiment was made, in which the wire was carried from one floor of house to another, and messages transmitted.

3rd. Attachments were made to a line of telegraph wire, and various forms of terminals tried, when it was found that musical and other sounds were readily transmitted. The attachments were made by No. 23 copper wire, and the experiments were tried at distances of 75 and 150 yards. It was found that there was no appreciable loss in the intensity of the sounds at the greater distance, although an intervening post had to be passed. Breathing, whistling, singing, and the sound of a small tuning-fork, were readily transmitted. Speaking was indistinct, although the word sounds were discernible.

The author believes that, under more favourable conditions, communications might be made in this manner through considerable distances.

4th. About 50 yards of No. 23 copper wire were laid out on grass, and fastened up at ends to pins; attachments were then made, and vocal and other sounds transmitted.

The terminals used were composed of various materials, and were of various forms—the best results were, however, got when the disc or vibrating parts were of pasteboard. If the discs were set in deep rims, clearness of speech was best got by speaking back a few inches from the mouth-piece. With shallow rims the sounds were sharper, but not of such volume.

The best results were got when the wire was attached to centre of disc. Good results, however, were got, although the attachment was made in various ways.

The wires tried were of copper, steel, and iron; the copper wire, however, gave the most satisfactory results. In the case of the telegraph wire, which would be about $\frac{1}{8}$ inch thick, and of iron, the volume of sound was considerable; and, indeed, the volume of sound seemed to be increased with heavy wires.

Some interesting results were got by using a common iron wire fence, and attaching terminals at various points apart in the wires of which it was composed. The fence was made up of six wires of $\frac{3}{16}''$ and $\frac{1}{4}''$ diameter, and had iron supports at every six feet of its length.

It was found that speaking, singing, whistling, &c., could be transmitted through distances varying from 20 to 60 yards, and that the sound of the tuning fork passed through 100 yards.

Attachments were made to ordinary bell wires, and speaking, singing, &c., could then be transmitted from one room to another.

In all cases the individual voice could be distinguished, and sounds not immediately addressed to the transmitting disc could be heard. Two persons singing together could be heard very beautifully.

The vibratory movements of the discs were insufficient to cause fine sand strewn upon them to move.

From his experiments the author believes that a large part of the vibratory movement must take place in the interior of the wire. This at least seems obvious in the case of the wire resting on the carpet, which showed an improvement in clearness of transmission when kept still by resting on the surfaces with which it was in contact.

From the fact that whisperings and breathings can be transmitted through considerable distances, it is evident that a very small part of the energy expended at the sending terminal can be lost by inducing permanent strain, or by heating the particles of the wire during the transit, and that, in consequence, with suitable arrangements, messages might be transmitted for considerable distances.

(*To be continued.*)

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

VIII.

SINGLE CURRENT SYSTEM WITH RELAY—(*continued*)

THE line current in the single current system being only in one direction, that is to say, its tendency being only to move the relay tongue over to the screw stop connected to M, or towards the "marking" side, a bias has to be given to the tongue which shall normally draw it over to the insulated stop on to the "spacing" side. The amount of the bias required varies with the strength of the line current, and must be regulated by turning the adjusting screw of the relay.

SOUNDERS.

The use of the "Sounder" as a signalling instrument has been for a long period universal in America, but in England it is only within the last few years that it has been introduced; its employment at the present time in the Postal offices is very extensive, there being over 1,500 in use. The forms of the instrument are of two kinds, viz., the standard pattern, which is adopted for all new instruments, and a larger form, which has been constructed partly out of the materials which formed portions of the old "embosser" Morse instruments, which were used to some extent by the Electric and International Telegraph Company. This latter form of instrument, although not perfect in design, answers very well in practice, and a considerable number are at present in use. Fig. 37

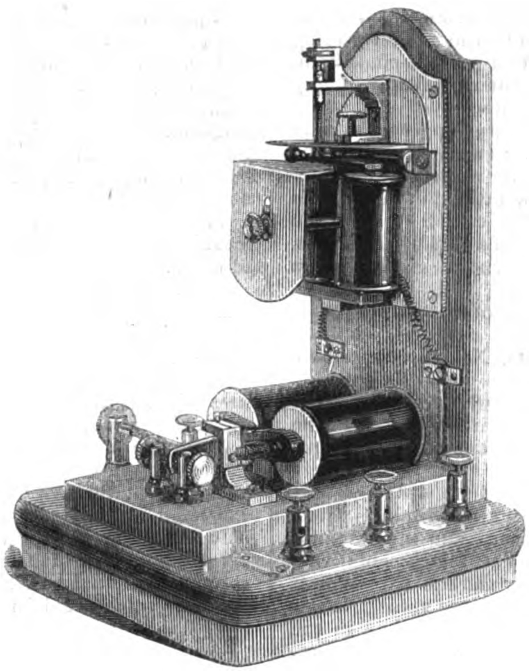


FIG. 39.

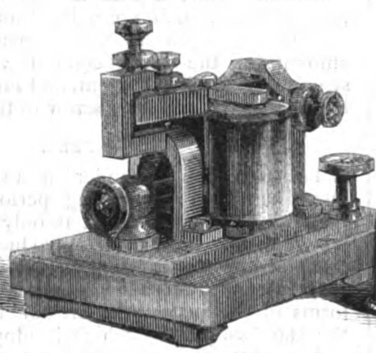


FIG. 38.

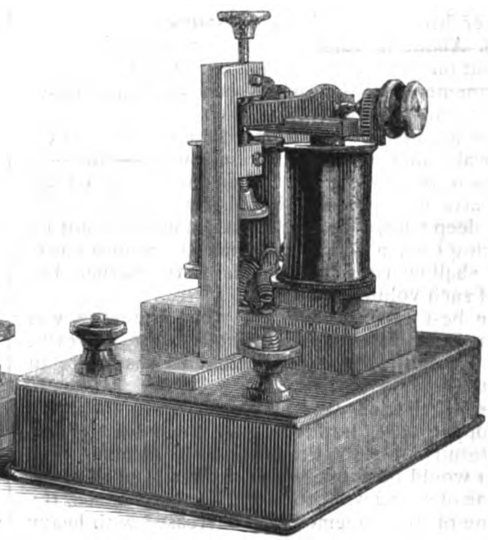


FIG. 37.

shows this form of sounder. It is mounted on a hollow wooden base, which gives considerable power to the signals. The standard pattern is shown by fig. 38. The lever of this instrument is very solid in form, so that the sounds obtained are very marked, with a very slight amount of play between the limiting stops. The brass base on which the magnet coils, and bridge piece carrying the screw stops are secured, is hollow, to increase the sound given out. The small amount of play to which a sounder can be regulated is very essential for quick action.

As regards adjustments, it is first of all essential that there be a certain amount of play, or "end shake," between the axle and the screw bearings in which the former works; the amount of this "end shake" required is very little, but still a slight amount is absolutely necessary. The lock nuts securing the axle screws should be always kept tight, and should therefore be looked to occasionally, as the constant jars consequent on the working of the instrument is liable to loosen them in time. The lock nuts which tighten the screw stops, between which the lever plays, should also be kept tight. It will be noticed that the screw stop in the standard pattern which limits the downward play of the lever is screwed into the lever itself. This is a much better arrangement than having both the stops screwing into the bridge piece, as they can both be very easily got at and adjusted, which is not the case with other patterns.

In adjusting the sounder for ordinary working, the screw limiting the downward play of the lever should be so set as to allow a clear but small amount of space between the armature and the poles of the electro-magnet.

The sounders, when used for "direct working" (which is rarely the case) are wound to a resistance of 300 ohms; for local working by means of a relay, the resistance of the coils is 40 ohms. The direct working instruments should work well with a current of 7 milliwebers.

Theoretically, and practically also, the maximum "pull" of the magnet on its armature would be obtained if its resistance were equal to that of the battery used to work it; as a matter of fact the resistance of the battery is usually considerably in excess of this. It might, therefore, be thought that a better and more economical effect would be produced by winding the coils to a higher resistance, but there are other considerations besides mere "pull" to be taken into account. Quick working on a local circuit cannot be obtained with instruments of a high resistance, and numerous experiments and practical experience have shown that with the batteries in general use 40 ohms is the resistance which best answers the requirements.

A very great point in the Sounder instrument is its extreme simplicity and its small liability to get out of order.

The rattle of a number of Sounders in a large office might be considered objectionable, but this inconvenience is got rid of by screening off each instrument, or by enclosing the same in a kind of wooden hood, which, to a great extent, confines the sound to the locality where the Sounder is placed.

The Sounder, although sometimes worked direct, is more frequently worked by Relay; the connections in cases where the working is by "single current," with relay, are similar to those shown by fig. 36 in the last article.

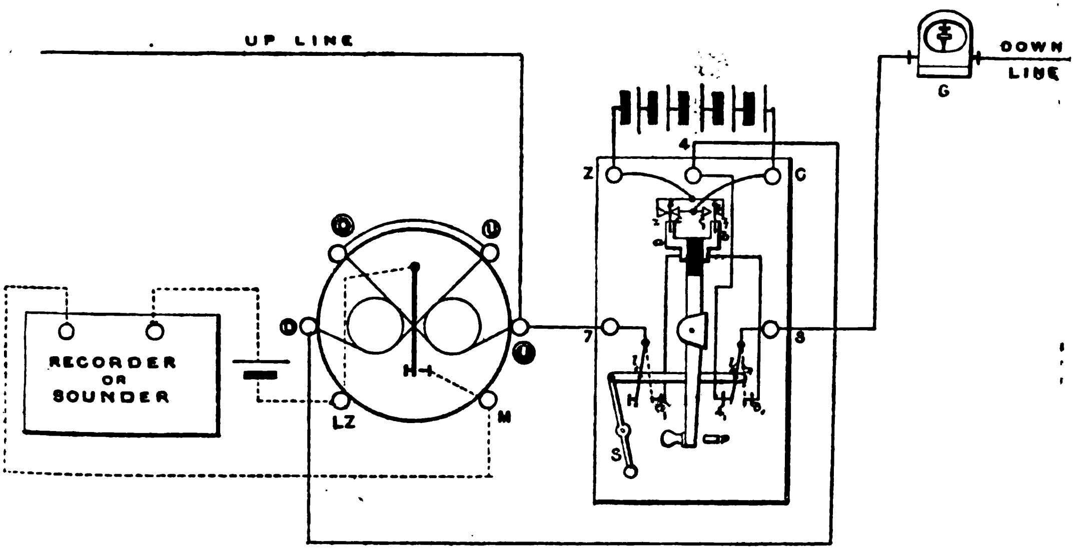


FIG. 40.

The Bell Sounder.

This form of instrument, which is shown by fig. 39, is used to a limited extent in some of the Postal offices. It consists of a relay and Sounder arranged on a single frame, and is, in principle, merely a "Bright's Bell" instrument cut in half, that is to say, the relay is similar to that employed on the instrument referred to, only one tongue is employed instead of two, and there is only one local bell. The latter is provided with two sounding

plates, between which the hammer of the instrument plays, the upper plate corresponding to the upper screw stop, and the lower plate to the lower screw stop of the ordinary Sounder.

The connections of the instrument possess no peculiarities, being similar to those of an ordinary relay-worked circuit. The resistance of the relay is about 400 ohms; the local Bell has a resistance of 40 ohms.

The tongue of the relay being pivotted between two pointed screws, care should be taken that the upper one of the two is screwed sufficiently down to allow only a very slight amount of up and down movement or "end shake" of the tongue. If the play allowed is too great it will cause the contacts, and, consequently the signals, to be irregular. If, on the contrary, the screw be screwed down too tight, the tongue will be jammed and will not respond at all. The lock-screw securing the upper screw should always be kept tight.

DOUBLE CURRENT SYSTEM.

Single Current working, with Relay, from its simplicity, is very useful for lines which are beyond the range of direct working; but which, at the same time, are not of an excessive length. Now, in the Single Current system, as has been pointed out, the line current has to work against a magnetic pull, or bias, which is of a fixed and unvariable strength, unless altered by turning the regulating screw, consequently variations in the line current have to be allowed for by changing the adjustment. On long lines, which are much and continually affected by climatic changes, the need of this continual alteration would prove very troublesome; besides, even if the current did continue constant for any length of time, it would often be too weak to work the tongue of the relay against the necessary bias; on such lines, therefore, the "Double Current" system is adopted. In this system the relay tongue is set neutral, or very nearly so, and the key, on returning to its back position, sends a reverse current, which carries the tongue back to the "spacing" side. To enable signals to be received, the key is provided with a switch, which cuts off the battery and puts the line direct through the receiving relay.

The arrangement of the "Double Current" system will be seen from fig. 40, in which the general principle of the double current key is shown. The lever of the key has two insulated portions, a, b, which are respectively connected to the contact stops, a_1, b_1, of the levers, l_7, l_3; the pieces, a_1, b_1, are provided with prolongations, s, s_1, which play between the contact points, z, z_1, and c, c_1; these points are severally connected with the zinc and copper poles of the battery. Lever l_3 is connected to terminal 3, which is connected to the "Down" line through the galvanometer, G; lever l_7 is connected to terminal 7, and the latter is connected to the U_0 terminal of the relay, and also to the "Up" line. The contact point, 4_1, is connected

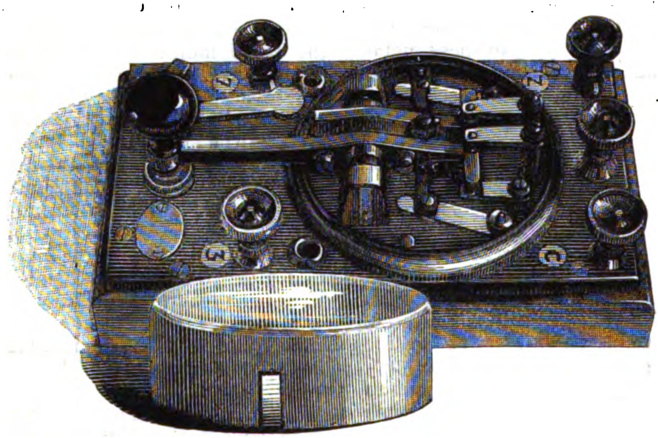


FIG. 41.

to terminal 4, and the latter is connected to terminal D of the relay. The levers, l_3, l_7, are moved by means of the switch handle, S; with the latter in the position shown, the apparatus is ready for receiving signals. Supposing the current to come in from the "Down" line, its course is as follows:—From line, through the galvanometer, G, to terminal, 3, from thence to lever l_3, and contact point 4_1, thence to terminal 4; and from there to terminal D of the relay, and through the latter to terminal U_0 and the "Up" line.

When it is required to send, by means of the key, the switch S, and consequently the levers l_3, l_7 connected to it, are moved to the positions indicated by the dotted lines. On depressing the key, the Zinc pole of the battery becomes connected to a, through s coming in contact with z; from a the current passes to lever l_7 through contact point a_1, and from thence to terminal 7 and the "Up" line. The "Copper" pole of the battery comes into connection with b_1 through contact point c_1, and the spring s_1, and thence through b, and l_3 with terminal 3 and the "Down" line.

The connections shown are those for an "Intermediate" station. If the apparatus is at an "Up" station, then terminal 7 of the key or terminal U_0 of

the relay must be put to Earth. If the instrument is at a "Down" station, then the right-hand terminal of the galvanometer G must be put to earth.

It may be noticed that theoretically the lever l_7 is not required, as no current can flow to line from the battery so long as l_8 is moved over to the position indicated by the dotted line; but practically it is found better to cut off both poles of the battery from the apparatus, for if the battery were not well insulated, a "Copper" current, more or less strong, might flow out to the "Up" line, although the Zinc pole of the battery was disconnected.

The actual form of the most recent pattern of the Double Current key is shown by fig. 41. It consists of an ebonite base board screwed on to a wooden frame. The key lever is hinged to two brass hinge blocks, insulated from one another, and connected respectively to the platinum contact points of the switch levers. The lever of the key is formed of two metal parts, insulated from one another by a piece of ebonite between the two; to these metal pieces are screwed the axles which turn in the hinge blocks. The right-hand metal piece is extended, and to it is fixed a knob made of buffalo horn.

The ends of the metal pieces are bent round at right angles, as shown by the fig., and are faced with platinum contacts underneath at their extremities; these contacts normally rest against platinum-tipped springs, corresponding to the contact points, c, c_1, on fig. 40. The upper parts of the angles are likewise furnished with platinum contacts, which when the key lever is depressed, make contact with springs corresponding to the contacts, z, z_1, in fig. 40.

The levers, l_8, l_7, are linked together by an ebonite bar, which is itself linked to the switch handle, S (fig. 40).

The key lever is held in its normal position by a spiral spring connected to an adjusting screw, by which the tension of the former can be regulated if necessary.

THE ROYAL SOCIETY CONVERSAZIONE.

THE Annual Conversazione of the Royal Society was held at Burlington House on Wednesday, April 28th. The spacious rooms belonging to the Society were well filled by representatives of every branch of physical science and by visitors interested in the choice collection of exhibits which is always to be found at the Society's conversaziones.

The microscopic specimens, microscopes, spectroscopes, and philosophical instruments of a like nature mustered in strong array; Messrs. J. Browning, Elliott, Powell and Lealand, Professor A. S. Herschel, exhibiting instruments of very perfect manufacture.

Electrical apparatus was well represented. The President exhibited a Töppler's Influence electric machine, with twenty plates. Messrs. W. Ladd & Co. showed in action one of their well-known six-plate Holtz electrical machines, with ebonite plates; these machines, having their parts enclosed in an air-tight case, are not affected by damp, and hence are always ready for use when required. The same firm also exhibited an improved laboratory Gramme machine, with circular magnets.

The General Post Office showed in action one of the latest forms of Wheatstone's automatic telegraph instruments. This instrument, which is specially constructed for high speed working, is made in two parts, the one consisting of the transmitting portion proper, and the other part being the driving mechanism; by having the latter distinct repairs are more easily executed. By a peculiar and ingenious arrangement the transmitting portion can be easily disconnected from the driving train when required.

Mr. H. R. Kempe exhibited an electrical speed indicator for slow speed engines. Almost all the speed indicators hitherto constructed have been on the centrifugal principle, and require to be adjusted and graduated by trial, and, moreover, require to be fixed close to the driving power whose speed it is required to know. In Mr. Kempe's invention the speed indicator is timed by means of a clock, and thus gives absolutely accurate results, and, moreover, can be placed at any distance from the engine whose speed it is required to indicate. The apparatus is so arranged that at every minute the indicating hand moves to the number of revolutions the engine has made during a particular minute, and remains at that point until the next minute, when it moves backwards or forwards to the number of revolutions the engine has made during that next minute, supposing the revolutions to have been less or greater.

Messrs. Elliott Brothers exhibited a portable reflecting astatic galvanometer, a set of resistance coils, and one of Dr. Lodge's electrometer keys.

Mr. Apps showed a new arrangement of resistance coils, and a Wheatstone bridge, with Admiral Selwyn's galvanometer. A small model electric lamp, for the production of light by arc or incandescence was also exhibited.

Mr. H. A Severn showed his electrical warning compass, by means of which a bell is rung if the ship deviates from her proper course. The invention is as simple as it is effective.

Besides the foregoing, there were a large number of exhibits of philosophical instruments, connected with every branch of physical science, which space will not permit us to allude to.

Notes.

IN the Court of Appeal on Tuesday, April 20th, the case of the Manchester and South Junction Railway Company *v.* the Queen was concluded. It was an appeal by the company against a decision of the Court of Queen's Bench upholding the refusal of the Postmaster-General to pay compensation awarded to the company for the loss of the control of their telegraph wires. The question was whether, under the Telegraph Acts, giving the Postmaster-General power to purchase telegraph lines on railways, he could do so by purchase from the telegraph company without compensating the railway companies. The telegraph lines on this railway having been purchased from the tele-

graph company, who held them under an agreement, unlimited in duration, from the railway company, the railway company claimed compensation and obtained on arbitration, accepted under protest by the Postmaster-General, an award of £6,479. The Postmaster-General declined to pay, on the ground that the arbitrator had no jurisdiction, and on a petition of right by the company to enforce the award the Queen's Bench Division decided against them. The argument urged on behalf of the company was in effect that the railway company had transferred to the telegraph company the power of sending telegrams for money, and that that was all that the Postmaster-General had taken. Their lordships now affirmed the judgment of the Queen's Bench against the company.

AT the last annual meeting of the Paris Physical Society M. Trouvé exhibited his electrical polyscope. The object of this instrument is the illumination of the internal organs of living bodies. An instrument was placed in the stomach of a live fish and the animal illuminated by passing a current through the apparatus. It is stated that the fish did not show any signs of uneasiness, but swam about the aquarium in which it was placed in a quiet manner.

BEFORE the same Society M. Marcel Deprez recently described a new galvanometer adapted for the measurement of powerful currents. The apparatus consists of a number of soft iron needles set between the poles of a powerful permanent horse-shoe magnet, and are thus magnetised by induction. A few turns of thick wire are wound around the needles in a direction parallel to their length; thus a galvanometer is formed, the needles of which are held in a state of equilibrium by the powerful directive action of the permanent magnet, and are thus only able to turn through an angle of a few degrees by a powerful current.

M. DEPREZ also exhibited an apparatus for measuring the amount of power developed by a current. The instrument consists of an electro-dynamometer formed of a movable coil which can turn within a fixed coil. A portion of the current whose energies to be measured passes through the outer coil, and a smaller portion through a resistance and through the inner movable coil. By noting the turning power exerted on the movable coil, the amount of work exerted by the current can be accurately determined.

IF rumour speaks truly, we are to hear shortly of another scientific invention worthy to stand beside the telephone or the phonograph in point of interest. Announcements of a mysterious *telephote* or *diaphote*, the discovery of two rival American inventors, have lately appeared in the paragraph columns of the non-scientific press, the instrument or instruments in question being declared capable of transmitting light as the telephone transmits sound. The rumour to which we allude, however, and of the truth of which we have authoritative information, is based upon the fact that Prof. Graham Bell has deposited in the Smithsonian Institution a sealed package containing the first results obtained with a new and very remarkable instrument first conceived by him during his sojourn in England in 1878.—*Nature*.

WE learn that Messrs. M. Theiler and Sons are about to bring out a new telephone. The transmitter is said to be exceedingly simple, requiring no adjustment whatever, while the receiver is stated to be much louder, without being less distinct, than the Bell telephone. We hope to describe the apparatus fully in our next issue.

MR. W. T. HENLEY is manufacturing a 3-inch cable for the Montreal Telegraph Company. The dielectric of this cable is formed of an ozokerit compound.

ACCORDING to some experiments made by M. Ziloff, the magnetic co-efficient of an aqueous solution of perchloride of iron varies with the magnetising force.

MR. JAMES SIVEWRIGHT, general manager of the telegraph between the Cape of Good Hope and Natal, has been gazetted to the most distinguished Order of St. Michael and St. George, for services rendered in South Africa during the late war.

THE catalogue of the Ronald's library has been completed by Mr. A. J. Frost, and will shortly be ready for publication. The catalogue will be something more than a mere list of the works contained in the library, as many valuable notes have been compiled and printed in the volume.

A COURSE of lectures on "Electrical Testing as applied to Telegraphy" is now been delivered by Professor W. C. Adams, at King's College, London. The series commenced on Friday, 23rd inst.

THE report that the Western Union Telegraph Company have paid Mr. Edison 100,000 dollars for the sole right to use his electromotograph in connection with telegraphy, is stated to be incorrect. The company having paid only a nominal sum down, the remainder being conditional on their working the patent, which they are not likely to do.

MM. LEBLANC and LOISEAU have invented an automatic electrical railway block telegraph instrument. The apparatus consists of a lever or pedal, placed close to the railway metals, so that it can be moved by the action of the wheels. The movement of the lever acts upon a relaxing arrangement, which in its turn works a commutator. Thus the apparatus serves to put a battery in communication with an electric bell at the signal station. A peculiarity in the arrangement lies in the fact that the lever is moved by the action of the first wheel of the train, and then remains moved away until the last carriage has passed, thus the lever is not subjected to the hammering of each wheel as it passes, which would result in the derangement of the mechanism in a very short time if continued.

ACCORDING to Le Comte du Moncel, a little ball of pith is strongly attracted by a strong horse-shoe magnet, the poles of which are provided with large soft iron pipe pieces, placed very close together. The phenomenon is very marked at a distance of four centimetres.

THE Edison Telephone Society is now in full operation at Paris, with over 350 subscribers. The carbon transmitter and the Phelps receiver are used. The lines are laid down by the State, and a complete closed circuit is employed in order to avoid induction currents. Successful experiments have, it is stated, been made up to distances of about 140 miles.

THE WIRE AGE.—Until within the past four years the wires were capable only of transmitting signals of a complex nature, but easily understood and interpreted by experts; now, human beings talk with each other over the iron, and it seems to make, as it were, a unit of the great family of man. Words, actual words, produced by the organs of speech, are ever winging their way, with the speed of lightning, over cities,

across rivers and mountains and woods, and voices are recognised scores of miles away. The wires needed in cities for transmitting fire and burglar alarms, for police calls, time signals, and other municipal purposes, are many in number, and when to these are added the wires for telegraphic and telephonic purposes, the question of space or room for them becomes an important one. These wires must all be independent of each other; there must be no contact anywhere, else serious errors and complications occur. In this city the fire alarm system has been so often interfered with that the chief engineer has called the attention of the city government to the matter. The time is not far distant when additional wires will become necessary for the purposes of electric lighting, and, perhaps, warming. In the years to come the whole country will be covered with them unless some plan is devised by which electrical currents can be conveyed in the earth by wires protected in tubes of clay or metal. It is certain that some method of this nature must be adopted, and that quite speedily.—*Boston Journal of Chemistry.*

UNDER the title of Electrical Gyroscope, MM. De Fonvielle and Lontin have brought before the Paris Academy an apparatus for producing gyratory motion by electrical means. The instrument consists of an ordinary horizontal galvanometer coil, within the axis of which can be balanced like a compass needle pieces of soft iron of various shapes, such as a star, a disc, &c. If one of these pieces of soft iron be suspended, and a series of rapidly reversed currents be sent through the coil, then on imparting a rotatory motion to the soft iron disc or star the latter will continue and rapidly increase its rate of revolution until an extremely high rate of motion is attained. If a permanent horse-shoe magnet be placed vertically over the coil, with its poles downwards, then it is found that if the poles are on a line parallel to the wire of the coil, the motion of the rotating mass of iron is accelerated; if, on the contrary, the poles are set at an angle to this position, the motion will be retarded, and if the angle be a right one, then the motion is generally stopped. The phenomenon is accounted for by the discoverers in the following way: —The molecule of iron acts in its movement of rotation in two different ways in each of the two nearly equal currents of induction which successively traverse the turns of wire. In fact, during the whole continuance of the two phases of rotatory movement which the galvanometric frame brings closer together, each molecule of soft iron increases the intensity of the current which affects it, and at the same time it diminishes that of the current which repels it. In the two other phases of its movement the same molecule diminishes the intensity of the one current, which then tends to draw it back, and increases that of the other current, which turns it away from the frame. The actions exerted in the two phases of the movement, that is, in the total extent of the plane described by the molecules, tend then to keep up the continuous rotation, which progressively increases in speed until it reaches that which corresponds to the absolute intensity of the attractions or repulsions exercised by the currents induced.

WABASH, Indiana, has been successfully lighted by electricity. On the night of the first day of April four Brush lamps of 3,000 candles power each put forth a noonday light for one mile in circumference. The lamps, suspended midway of the iron flagstaff on the Court House, which towers one hundred feet above the business part of the town, were furnished with electricity by a No. 5 generator, driven by a seven horse-power engine. According to contract the light was to equal a gas burner 2,640 feet from the light, and it gave general satisfaction. That city is the first in the world to adopt the electric light for general illumination.

THE electric lighting of the Metropolitan Aldersgate Street Station during the last seven months has given such satisfaction that the Railway Company have determined to adopt it for several other stations as well. The light will be temporarily discontinued in order that the Electric Generator and Light Company who are supplying it may make the necessary arrangements for the permanent lighting.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

AT the ordinary general meeting of this Society, held April 14th, Mr. W. H. PREECE, President, in the chair, the minutes of the last general meeting having been read and confirmed, a note by Prof. HUGHES on "Some Effects Produced by the Immersion of Iron and Steel Wires in Acidulated Water," was read by the SECRETARY.

It was found that if steel wires were immersed in acidulated water containing $\frac{1}{10}$th of its volume of sulphuric acid, the wires became very brittle. That these results were not accidental was proved by repeated experiments. The proportion of the acid in the water did not affect the results. The effects noticed were only produced in iron and steel, other metals were not affected. The effect produced was probably due to hydrogen being absorbed, but the metal rendered brittle did not possess any peculiar property observable on the "Induction Balance." If the acidulated water was weak, then a proportionately longer time was required to produce the brittleness. With part of acid to 20 of water the time required was 30 minutes. If the steel acted upon formed the electrode of a cell with copper as the other metal, then the effect was much more marked when the cell had its circuit kept closed. If zinc was used instead of copper, the effect was less marked.

Any kind of acid produced the effect noticed, but the time taken to produce the effect varied with the nature of the acid. The effect could also be produced in water if another metal were coupled to the steel.

If steel wires are plunged into acidulated water with hydrogen developed in it by means of the action of zinc the brittle effect produced was very marked. Rods of a quarter inch diameter were affected equally with thin wires, but the time in the various cases differed according to the thickness of wires or rods. Heating the brittle wires restored their flexibility.

It was found that an iron wire plunged into acidulated water became more electro-negative after a time than at first. As soon as the hydrogen began to develop, the degree of polarity became constant.

Short circuiting a cell formed of iron and zinc at once made the cell constant. Iron produced a much better effect than platinised silver, as in a Smee cell.

By plunging an iron rod into mercury containing zinc covered with acidulated water, the zinc dissolved out very rapidly, and the metal could thus be easily purified.

If several metals were coupled up together and connected to a zinc in acidulated water, the iron alone gave out hydrogen. Carbon became most polarised of any metals in a cell.

Mr. CHANDLER ROBERTS then read a note on Prof. Hughes' communication. Graham showed that all metals absorb gas, and that palladium "occluded" 900 times its volume of hydrogen if heated in the latter, and then allowed to cool or made the negative-electrode in a battery. The effect of the absorption was to expand the metal 2 per cent. Platinum also absorbed hydrogen and became expanded in so doing. This was shown by experiment, the platinum electrode being connected to a long light index which showed the expansion. If the direction of the current through the cell was changed so that oxygen became developed on the piece of platinum in question, then contraction took place, the effect in both cases being slow. Mr. Roberts suggested that in Professor Hughes' experiments hydride of iron possibly became formed.

As regards some experiments made with thin films of iron, it was suggested that acid and not hydrogen became absorbed in the pores of the iron.

The reason of the brittleness produced in the steel was difficult to get at; possibly it was caused by the entry of the hydrogen re-arranging the particles of iron and causing a crystalline effect.

Prof. ABEL stated that he had made some experiments on the brittleness of steel, and he took the same view of the matter as did Mr. Roberts. The quantity of natural gas contained in iron varied from 3 to 10 per cent.

Mr. STROH had made some experiments to determine the depth of the brittle structure of the steel. A rod ½-inch thick was plunged into acidulated water for half a minute, and then filed to remove the surface. The brittleness was not removed by this process. A repetition of the filing for several times proved that the brittleness had penetrated the mass of the metal. The "tensile strength" was *not* altered by the action of the acid.

Mr. ANDERSON, who had served on the hardening and tempering of steel committee, thought that the effect of hydrogen was to allow the opening or drawing closer of the particles of iron.

When heated steel is suddenly cooled, the particles come together very quickly, and the effect of hydrogen may be similar.

Prof. ADAMS pointed out that the experiments bear in one direction, viz., upon the separation of the molecules of the metal; the effect, therefore, may be to reduce the cohesion. It is well known that alloys of metals have a lower melting point than that of the metals individually, the reason being that cohesion is diminished.

Mr. WILLOUGHBY SMITH said that formerly the joints in the copper conductors of cables were formed by silver-solder, with resin as a flux. These joints became very brittle. With soft solder and spirits of salt as a flux, the joint became brittle if the spirit was not washed off after the joint had been made.

Prof. PERRY considered that Mr. Stroh's experiments on the tensile strength of the steel arms were not conclusive. In reply to Prof. Adams, he pointed out that some alloys are actually stronger than the metals individually.

Mr. KEMPE next described some experiments he had made, at Prof. Hughes' request, to determine the electromotive forces of various couples. The results obtained were as follows:—

Battery.	Electromotive Force.
Daniell	1·00
Zinc—Iron	·56
„ —Copper	·95 (variable)
„ —Amalgamated Copper	·16 „
„ —Carbon	1·21 „
„ —Platinum	1·05 „

The polarisation observed on short-circuiting the battery for one minute was as follows:—

Daniell	9·7 per cent.
Zinc—Iron	12·0 „
„ —Copper	50·0 „
„ —Amalgamated Copper	45·0 „
„ —Carbon	60·0 „
„ —Platinum	51·0 „

The Zinc-Iron couple gave a very steady current.

Mr. TREUENFELD stated that the effect of galvanising wire was to render it brittle.

Prof. AYRTON said that when the elements of a battery were first immersed in the fluid the electromotive force rises.

Mr. J. MUNRO suggested that the effect of hydrogen was to fill up the pores of the steel wires experimented on, and thus, by preventing the yielding of the metal when bent, to cause the brittleness.

Prof. HUGHES in reply stated that contrary to the generally accepted theory, iron forms an excellent negative element for a battery. The electromotive force of a zinc-iron couple is very high, and the resistance very low.

The PRESIDENT pointed out that the use of iron for batteries was first prominently brought forward by Callan of Maynooth.

Mr. STROH next read a paper on "The Adhesion of Metals, produced by Currents of Electricity." If two steel wires were brought into contact with one another crosswise, a battery being connected to them, the wires adhered with a considerable amount of force. A single bichromate element was sufficient to cause this effect. If the battery were increased, the adhesion was diminished. Experiments were tried with two knife edges brought in contact crosswise, a current flowing between them. The amount of power required to separate them with different metals was found to be as follows:—

Copper	·15
Silver	·15
Aluminium	2·50
Brass	8·50
Zinc	11·00
Tin	14·00
Gold	17·00
Lead	18·00
German silver	28·00
Platinum	42·00
Iron	85·00
Soft steel	100·00
Hard steel	225·00

By examination of the contact edges under a microscope, it was found that the effects were due to fusion. It was noticed that the points of adhesion, in the case of steel, became extremely hard. The knife edges, when stuck together, would bear a considerable amount of tension without becoming separated. In the case of steel edges, the striking power was so great that a half-pound weight could be hung to them without producing a separation.

The PRESIDENT having made a few remarks, the meeting then adjourned.

AT the ordinary general meeting of the Society, held April 28th, Mr. W. H. PREECE, President, in the chair, Professor AYRTON gave the results of some experiments made to determine the quantity of current flowing in the electric arc, by observations of the shapes of the crater produced in one of the electrodes. The results obtained were as follows:—

Depth of crater. Inches.	Area of crater. Inches.	Current in Webers observed.	Current calculated from crater.
·140	·0196	9	9·9
·156	·0243	12	12·4
·186	·0272	...	13·8
·203	·0324	...	16·5
·266	·0556	29	28·3
·326	·0825	42	42·0
·453	·1602	81	81·6

A paper by Mr. OLIVER HEAVISIDE on "The Resistance of Galvanometers" was then read. In this paper the author showed that whatever the shape of the coil was, and whatever the thickness of the silk covering on the wire, the law that the maximum effect was produced by the coil when its resistance was equal to the external resistance, always held good.

A paper by Mr. C. HOCKIN, M.A., on "The determination of the position of faults in a cable when two exist at the same time," was next read by the SECRETARY.

Mr. HOCKIN first pointed out that when tests could only be made from one end of a cable, the difficulty of localising a fault was very great, owing to the continual variation in the resistance of the fault. A method had been suggested of localising faults by taking a resistance and a discharge test; the latter was a matter of some difficulty, owing to a large portion of the current becoming lost whilst the discharge key was moving from its charge to its discharge contact.

In localising faults eleven different measurements were possible, of these six were resistance measurements, two potential measurements, two current measurements, and one a ratio measurement. By combining these tests it was found that in the case of a cable with two faults an equation of the third degree could be obtained, which would enable the locality of the faults to be obtained. The solution of this equation could only be obtained by the "trial" method, but this could be done without a great number of numerical calculations, ten trials usually being sufficient to enable the result required to be arrived at.

In the discussion which followed the reading of Mr. Hockin's paper, Mr. KEMPE pointed out that the difficulty mentioned by Mr. Hockin, with reference to a test made by a resistance and a discharge measurement, had been overcome by himself, and the method had been described in the TELEGRAPHIC JOURNAL for September 15th, 1879.

Mr. H. R. KEMPE then read a paper on "Testing by Received Currents." The good maintenance of a system of telegraph lines can only be accomplished in a satisfactory manner by a good system of testing. The need of some system is unquestionable, but no law can be laid down as to what is the best method to adopt. The system adopted in the Postal service in England was a very simple one, no elaborate formulæ or intricate tests being used or required. The stretches of line between any two testing stations did not exceed 15 or 20 miles, consequently, elaborate tests for localising faults were unnecessary. The station had merely to disconnect or earth the faulty line at their stations in succession, and then it was easily seen in which section the fault existed.

Two kinds of tests are made, viz.: "Monthly tests," for insulation and conductivity, by means of which the general condition of the lines is ascertained; and "Daily tests," by which the working condition of the lines is ascertained before the heavy day's work begins.

The monthly tests are taken by means of a Wheatstone bridge, the insulation test being made with zinc to line, and the conductivity tests, first with zinc and then with copper to line, the arithmetic mean of the two results being taken as the true conductivity. The tests are entered on printed sheets, certain deductions being made for the resistance of instruments and underground work.

The daily tests are made by sending currents through the various lines, and measuring the amount of current received at the ends of those lines. The amount of battery power sending the current being known, and the resistance of the line being also known, then by dividing the electromotive force of the battery in volts by the resistance of the circuit, the result obtained is the current going out and leaving the end of the line when there is no leakage; by comparing, therefore, this calculated result with the actual current received, the condition of the lines is at once known.

The measurements are made by means of a tangent galvanometer which has a coil of 320 ohms resistance and a resistance coil of 750 ohms. With the two resistances in current a standard Daniell whose electromotive force is 1·07 volts will give a current of $\frac{1\cdot07}{750+320} = \cdot001$ weber or 1 milliweber is obtained the deflection obtained, therefore, is equal to a current of 1 milliweber. If the standard battery be removed and the line put in its place, then the deflection obtained, which is due to the current from the line, at once represents the strength of the current by a simple proportion sum. Tables, to save the trouble of calculation, are used to estimate the values of the deflections.

The received currents are measured with the 750 ohms resistance in the circuit, so that if a line be faulty near the testing end the fault can be noticed; this would not be the case if there were no resistance in circuit, as the major part of the current would pass through the galvanometer, and but little through the fault, which would thus appear not to exist.

In the discussion which followed the reading of the paper, Mr. BETTS pointed out that the number of wires to be tested in the Postal offices was so large that even if elaborate tests were advisable they could not be taken for want of sufficient time. He had formerly had to test thirty-four wires in fifteen minutes.

Professor AYRTON said that he agreed with Mr. Kempe, with reference to the remarks he had made on the testing in India. In that country faults were enabled to be localised and traced out during the night; the stretches of line were very long, and thus accurate localisation by testing was necessary

In conclusion, the PRESIDENT said that the good working of the lines was greatly due to the efficient system of testing.

PHYSICAL SOCIETY.—APRIL 24th.

Professor W. G. ADAMS in the Chair.

New Members—The Marquis of BLANDFORD, Mr. J. MARSHALL.

Professor G. C. FOSTER read a note by Professor Rowland, of Baltimore, U.S., on the discovery of Mr. Hall, that a magnet exercises an electro-motive force on a current in a conductor crossing its field as well as a force on the conductor itself. This fact will render it necessary to apply a correction to equations which assume that only the latter force acts. The electro-motive force in question is at right angles to the direction of the current, and to the lines of magnetic force. Professor Rowland expresses it mathematically in this note, and bases a new method of determining the value of v, the ratio of the electrostatic to the electro-magnetic unit of electricity which gives v almost identical with the velocity of light, thus confirming Clerk-Maxwell's theory of the nature of light. Dr. J. HOPKINSON, F.R.S., suggested an expression for one of Professor Rowland's results.

Professor FOSTER also read a note by Professor Wild, of the Central Russian Meteorological Observatory, on a mode of correcting the bifilar magnetometer for

torsion of its fibres, &c., and a method for finding the horizontal component of the earthy magnetism by its aid.

Mr. RIDOUT, F.C.S., described an improved thermo-electric apparatus, of his construction. The author has followed the idea of combining the thermo-pile and galvanometer in one instrument on the same base-board. The defects of the apparatus, as ordinarily made, are a too great disparity between the resistance in the pile and in the galvanometer; the junctions of the pile are too deep, and short-circuit the current; the bars too long and resisting, as well as too numerous; the junctions too slender; the mass of matter to be heated too great. These defects are remedied by placing the bars in glass tubes, connected with thin plates of copper; making the bars half the usual length, and using only a single pair. The defects in the galvanometer are that the wire does not come near the needle; the needles are not of the best form; and the suspension is troublesome. Mr. Ridout makes the wire a flat ribbon mounted on one bobbin; the needles are flat oblong plates from the same piece of steel, and magnetised in one piece; they are mounted on a pivot turning in an agate cup. The several parts of the apparatus are mutually adapted to each other; and in using it the galvanometer is not joined to the pile till the latter has been exposed to the heat, so as to prevent the current generated abstracting heat from the hot side. As made by Mr. Browning the pile consists of a pair of elements $\frac{1}{2}$ in. long, the copper connections being circular plates $\frac{1}{100}$ in. thick, and $\frac{3}{8}$ in. diameter. The pile is supported by thick copper terminals above the galvanometer, which consists of a copper ribbon, making some 20 turns round a pair of astatic needles 1 in. long, and $\frac{1}{8}$ in. broad, pivotted in an agate cup; a contact key, placed on one side, and the whole is enclosed in a glass shade, perforated opposite the pile. A glass cone protects the front from extraneous heat, and a glass case the back. A directing magnet is fixed above the pile, contact between the galvanometer and pile is made after, say, 30 seconds' exposure to the heat. The pile is affected by a person standing 6 feet from it, and the radiation from stellar space is evident in clear weather. Half a minute is sufficient to put the instrument ready for use. Mr. Ridout also exhibited laboratory experiments showing cohesion in mercury by causing it to overflow up an inclined trough; electrolysis of water by a single Grove or bichromate cell, through diminishing the pressure in the flask containing the water by boiling it, and condensing the vapour on cooling; a differential thermometer showing absorption of heat on liquifying solids; and the production of musical notes in glass tubes by contracting the bore smoothly to about one quarter of the diameter at one part. Professor FOSTER remarked that the cohesion experiment might show the surface tension. Professor GUTHRIE and Professor HUGHES offered remarks on the electrolytic experiment, the latter stating that he finds the resistance of an iron cell, he has constructed, to depend on the electrodes rather than the liquid; when the negative plate is tempered iron, the resistance is low, when soft iron it is high.

Professor STONE exhibited photographs of König's new tonometer, described by him at the last meeting, and further mentioned that König had devised a thermometer based on the principle that changes of temperature produce corresponding changes in the vibration rate of a tuning-fork. The temperature is found from the rate of the fork by bringing it to a zero rate by means of a rider.

Professor MICHIN then described his experiments to solve the problem of transmitting light by photo-electric action. Two years ago he conceived the idea of employing for this purpose the fact that light falling on a sensitised silver plate disengages electricity. He forms a sensitive cell composed of two silver plates immersed in a conducting solution; one plate is coated with a sensitive emulsion of chloride or bromide of silver. When chloride is used a solution of salt in water forms the liquid, when bromide a solution of bromide of potash. A current is set up in this cell even in the dark, but when exposed to the magnesium light the current is very powerful and flows within the cell from the uncoated to the sensitised plate. Professor Michin also conducted this current by wire to a second cell in a dark chamber and found that it effected a decomposition of the sensitive plate in that cell, as shown by a distinct darkening of the plate when "developed" by pyrogallic acid. The same effect was produced whether the current was reversed or not. Professor Michin is continuing his experiments, and has provided a cable containing a number of separate conductors insulated from each other, in order to convey the currents from several cells.

Professor PERRY feared that the effect would not be strong enough; but Professor MICHIN said the light of a match produced a decided photo-electric effect in the cell. Professor PERRY alluded to the selenium plan proposed by himself and Professor Ayrton, and said that Mr. Willoughby Smith had observed selenium to be sensitive to the shadow of a flying swallow. Professor ADAMS testified to the sensitiveness of selenium and its power of being directly excited by light, a fact first proved by the experiments of Mr. Day and himself.

New Patents—1880.

1475. "Improvements in the manufacture of telegraph cables or conductors and in insulating apparatus therefor." F. WIRTH. (Communicated by M. M. & R. P. Manly and W. J. Phillips.) Dated April 10. Complete.

1496. "An improved machine, which, when placed in electric communication with a piano, harmonium, or organ, prints the music as it is played." HY. DICKINSON. Dated April 12.

1507. "Electric lamps." G. G. ANDRÉ. Dated April 13.

1510. "Insulators for supporting and securing telegraph and other wires." G. WELLS and A. GILBERT. Dated April 13.

1511. "Telephone switches." J. W. JOHNSON. (Communicated by E. Marx, F. Aklemm, J. Kayser, and L. Davis.) Dated April 13.

1552. "Electric lamps." A. M. Clark. (Communicated by M. A. Gérard-Lescuyer. Dated April 15.

1553. "Electric lamps." C. D. ABEL. (Communicated by the Compagnie Générale d'Eclairage Electrique.) Dated April 16.

1580. "Dynamo-electric machines." E. P. ALEXANDER. (Communicated by K. Zipernowsky.) Dated April 17.

1585. "Improvements in and appertaining to electro-magnets." G. SCARLETT. Dated April 17.

1649. "Improvements in and relating to electric lighting apparatus and the manufacture of carbonised material to form conductors for the same, and for other purposes. W. R. LAKE. (Communicated by H. S. Maxim.) Dated April 21.

1704. "Electric lamps." H. J. HADDAN. (Communicated by A. Bureau.) Dated April 26.

1705. "An improved bath or liquid compound for the deposition of aluminium." L. A. DAVIS. Dated April 26.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

3259. "Time indicators." MELVILLE THOMSON NEALE. Dated August 13. 6d. Has for its object improvements in the means of transmitting time by electric currents, and consists in the addition to any ordinary electric indicator of time of a relay arrangement, by which a local battery and circuit are thrown into action to move the hands of each indicator at the moment of a passage of an electric pulsation through the main or line circuit.

3368. "Joinings for wire fences, telegraph wires, &c." THOMAS YOUNG. Dated August 21. 2d. A rectangular slot is made through the joining or coupling piece in the direction of its length, and in each end of the said piece a hole or passage is made extending inwards to the slot. The holes are approximately of the diameter of the wires to be joined, and the said wires are passed through, and the end of each is flattened or broadened on the other side. *Provisional only.*

3436. "Galvanic batteries." R. C. ANDERSON. Dated August 26. 6d. Consists of the ordinary positive and negative elements, such as zinc and carbon, the former of which may be acted upon by any suitable acid, say for example sulphuric or muriatic acid, or a salt of an acid. With the latter is used oxalic acid in combination with a solution of bichromate of potash, to which is added a suitable acid or salt of an acid. These positive and negative solutions may be employed either mixed together as a one-fluid battery, or separately, by means of a porous pot dividing them as a two-fluid battery.

3476. "Microphonic apparatus." W. P. THOMPSON. (Communicated by M. Leon de Locht, of Liege.) Dated August 29. 6d. Consists in a very thin but rigid wooden, metal, or other "planchette" board or plate, which carries a prism of graphite, and is movable round one of its edges as an axis. The movements of the "planchette" are limited in one direction by springs, and their extremities in graphite, are limited in the other direction by the pressure of an antagonistic spring, which can be regulated at will.

3479. "Electric signalling apparatus for railways." W. ROBINSON. Dated August 29. 8d. Has for its object chiefly the automatic operation of electric signals on railways by means of passing trains, the rails of the track being used as principal conductors of the electric current.

3509. "Regulating mechanism for electric lamps." ROOKES EVELYN BELL CROMPTON. Dated September 2. 6d. Describes the regulator fully detailed on page 131 of our last issue.

3525. "Telegraphic recording apparatus." ROBERT KIRK BOYLE. Dated September 3. 6d. Relates to further improvements in apparatus described in a former patent, dated December 30, 1878, No. 5313, and is designated to provide means whereby the working of the said apparatus will be more accurate than has heretofore been practicable.

3565. "Dynamo-electric machines." W. ELMORE. Dated September 4. 8d. Describes the machine illustrated in our issue of April 1, 1880, page 116.

3587. "Electric lamps and switches therefor." F. J. CHEESEBOROUGH. (A communication from W. E. Sawyer, of New York.) Dated September 6. 6d. The lamp consists notably of a long carbon pencil interposed between two large carbon electrodes, the long carbon pencil being fed up magnetically from the outside of the globe in which the arrangement is enclosed. The globe is filled with a carbon preservative atmosphere.

3645. "Electric telegraphs." W. CHASE BARNEY. Dated September 11. 6d. Has for its object to increase the rapidity with which messages may be transmitted through long lines of electric telegraphs, and more particularly through submerged cables, by diminishing induction, by diminishing the duration of charge and discharge, and avoiding the effects of the secondary discharges on the receiving instrument.

City Notes.

Old Broad Street, April 28th, 1880.

EASTERN EXTENSION TELEGRAPH CO.—The thirteenth ordinary general meeting of this Company was held on Wednesday, the 21st inst., at the City Terminus Hotel; Mr. John Pender, M.P., in the chair. The report and statement of accounts were taken as read. The Chairman, in moving the reception and adoption of the report, delivered the following address: Gentlemen, before making a few general remarks, I will refer more particularly to the report. The gross receipts for the half-year ended December 31, 1879, have been £165,930; for the corresponding period of 1878 they were £140,976, showing an increase of £24,954. The expenses for the past half-year have been £68,683, for the corresponding period of 1878 they were £71,249, or a decrease of £2,566, caused probably by a reduction in the cost of repairs. The net revenue for the half-year has been £97,247; for the corresponding period of 1878 it was £69,726, showing an increase of £27,521. One interim dividend of 1¼ per cent., yielding £24,968, has been paid for the first half-year, and it is now proposed to distribute another of like amount on the 22nd instant, leaving, with the balance brought forward from the previous half-year, £81,970 for the reserve fund, which now stands at £157,870, or equal to about 8 per cent. of the share capital. I want to draw your attention particularly to this remark: the amount taken from the reserve fund in 1877 for laying the Penang and Rangoon cable, I believe, was £155,000. If this sum had been raised by 6 per cent. debentures the revenue would have been subjected to an annual charge of £4,000 for interest. The heavy cable repairs which the Company has had to pay since the amalgamation, a period of seven years, have cost £155,000. In other words, but for these repairs the shareholders might have had an increased dividend, say of about 1¼ per cent. If the ships' expenses when in harbour, which are also part of the cost of repairs, £63,000, are included, the total cost would be £218,000, or about 1½ per cent. per annum since the formation of the Company. The duplicate Australian cable has been successfully completed since the last meeting. It is laid direct from Singapore to Banjoewanje, thus avoiding the Java lines, by which a considerable saving of time has been effected, and increased efficiency obtained, as the messages pass now through English hands. A continuous night and day service has been established with Australia, and has given great satisfaction to the public, as we are now able to transmit messages, allowing for the difference of time, in about six hours. The interest on the new

capital raised on this cable is fully met by the Government subsidy of £32,400 per annum. It must not be forgotten that the addition of 2,500 miles of cable to the Company's already existing system of 7,369 miles makes a total of about 10,000 miles of cable, and involves an additional charge for keeping it in proper order, thereby rendering a reserve fund the more necessary. The China section of the cable is already worked night and day, and is adding very materially to the traffic of the Company, and it is also satisfying our constituents. . The transmission between London and China is carried on in about three hours. The Manilla section, which I referred to when I last addressed you, is now in course of being completed. We expect in a very short time to learn that the ship has laid the cable. That system is now incorporated with our present system. From that we also expect additional traffic. The cables, I am happy to say, are all in good working order, and probably I have never had any occasion to address you when the whole system has been in a more efficient and more satisfactory state for earning than at the present time. We are deriving some advantages from the improved state of trade; and, as I have often repeated, as trade begins to move, either upwards or downwards, telegraph companies are generally affected. Now, gentlemen, I have pretty well given you the real points referred to in the report which is in your hands, and beyond congratulations on the present very satisfactory position of the Company, the very large increase in the traffic, arising no doubt from, as I have said, an improvement in the trade and the duplication of our system to Australia, there is very little more to be said. There is one question to which attention has been drawn—and I may as well meet it at once—namely, the question of the reserve fund. I am bound to say, that looking to the history of submarine telegraphs, it is a property which cannot be considered a secure property unless we have our systems duplicated and our reserve fund at a point that will meet any emergency, and the requirements of immediate action in putting that system into order. If we had an inadequate reserve fund our property would be a fluctuating one, and I can see no sound ground for stability unless we have such an amount as will enable us to put our cable in order, and if necessary go largely into laying a new cable. Now, gentlemen, there is one point which I will refer to in support of this, and as illustrating more completely and more fully the views which I hold on the subject. I mentioned that when we laid the Rangoon and Penang duplicate cable we were not as well to do as we are at the present time, and we thought, instead of coming to the public with debentures, and making it almost a permanent debt on the Company, it would be better to take from the reserve fund the amount required to make that duplication. That received the approval of the shareholders generally. At the same time, in taking that amount from the reserve fund, we weakened our reserves to that extent. My proposition now is, and I hope that the shareholders who look to a steady dividend and a certainty instead of an uncertainty will support me in it, that we should replace that £150,060 before we talk of an increased dividend. If we go on at the same rate as we have during the past year that amount will very soon be obtained, and we will then stand with a reserve fund considerably over £300,000. We shall then be able to apply a fair proportion of our earnings to increase that sum, to bring it up to probably half a million, and at the same time to give to our shareholders an additional portion of dividend. Gentlemen, these are the views which your board hold. I think they are sound, practical, business-like views; and I am satisfied that it will be of great advantage to the Company and of this property in every sense if these views are approved of by the shareholders and carried out by your directors. If we pursue any other policy, and go and divide the amounts that we earn, all that I can say is that we shall not be studying the interests of a certain class of investors. There is a certain class of investor sin this Company who hold very small amounts, and there is no doubt that they prefer a safe and steady dividend of 5 per cent. to a fluctuating one, which it must be if we increase our rate at the present moment. I should be glad to hear any gentleman's opinion for or against the statement which I have made. I am hopeful that those who take my view will support it from the body of the meeting. Now, gentlemen, to be in form, I shall, before any one addresses us, move that the report and accounts of the directors, now submitted, be received and adopted, and that a dividend be declared of 2s. 6d. per share, payable on the 22nd inst., making, with the interim dividend already paid, a total of 3 per cent., free of income-tax, for the year 1879. The Right Hon. W. N. Massey, M.P., vice-chairman of the board of directors, seconded the motion. Mr. Marshall observed that it was suggested to the Company two or three years ago that they should take their 5 per cent. dividend and rest contented until the cables were duplicated. Now the cables were duplicated they were asked to rest until they had half a million reserve for repairs. It would therefore become a misfortune to the Company to have duplicate cables, because they were to be starved to keep them in repair. £27,000 net gain had been made during the past year; and he felt that as the Company had earned so much more during this half-year it was time to increase the dividend by what might be considered a fair amount, say to 6 per cent. They could well afford it. It would take only some £18,000, leaving £9,000 to be carried to the reserve. Taking into consideration the nature of the property and the very great risk the shareholders ran, he thought they should receive a higher dividend than 5 per cent. (Hear, hear.) He would therefore move that the matter of the dividend be referred back to the consideration of the directors, with a view to increasing the amount to 6 per cent. (Hear, hear.) He would also point out that the reserve fund was not £157,000, but £314,000, because a part of the latter sum had been invested in their duplicate cable. Therefore the Company stood very much better than appeared by the accounts. Mr. M'Laren Smith seconded the amendment, and remarked that he did not think that if it were carried it would at all alter the Company's prospects of obtaining a steady dividend. Mr. Newton, with reference to the question of proxies, complained that they were generally sent in in the most perfunctory manner, and he argued that therefore proxies were no criterion of the general desire for an increase of the dividend. Mr. Newton went on to say that he could not support the amendment because it was illegal, because of the articles of association, which he considered one of the most infamous documents ever proposed to a body of shareholders. (Hear, hear.) They were really a disgrace to an honourable board of directors. He objected to the resolution from the chair being backed with reference to proxies and to articles of association. It was his interest that only 5 per cent. should be paid. He had only a small interest in the shares, but both himself and his friends had considerable interest in the debentures. He protested against the reserve fund being only £150,000, and urged that it should be stated in full so that the shareholders might know what they would get. In a period of prosperity like the present, when the earnings were 2½ per cent. in excess of revenue, the shareholders should certainly participate to some extent. (Hear, hear.) Mr.

Griffith said that the chairman had recommended stability, but had he considered, whether unity was not better? Mr. Marcus suggested that the accounts for 1879 should be passed, and that the shareholders should then recommend the directors in the ensuing quarter or the ensuing year to pay the increased dividend if the prospects of the Company would permit of it. The Chairman: The directors are just as anxious to have harmony and unity betwixt themselves and the general body of the shareholders as the shareholders can be. At the same time we are in a better position to judge as to what is the policy in the interests of the great body of the shareholders. We have no personal interests to serve for ourselves; we have to look to the interests of the shareholders as a body. Now, just think for one moment, gentlemen, we have got 3,000 shareholders, but how many are represented at this meeting to-day? I do not suppose there are more than sixty people in this room. The interest of the few gentlemen who have spoken in this concern is insignificant. Mr. Marcus: I hold three hundred shares. Mr. M'Laren Smith: I hold ten thousand. A Shareholder: This is foreign to the question altogether. The Chairman: The great majority of the shareholders approve of our policy, and we are bound to carry out that policy. Mr. Newton has made some rather strong remarks as to the articles of association. He knows perfectly well what the articles of association have been from the beginning. He has made remarks which I am perfectly sure, when they are reported and when they come to the ears of the large body of the shareholders, they will decide that they are not prepared to leave their interests in Mr. Newton's hands. As to Mr. Griffith, he has made a very quiet statement, as he always does on these occasions, but I think that Mr. Griffith is not sufficiently careful. I do not think that Mr. Griffith has looked at both sides of the report. I do not suppose Mr. Griffith thinks that because we have ships they can be used to supply a new cable. They are a part of the plant necessary to the carrying on of an important work. Mr. Griffith must be perfectly aware that the only sum of money we have to deal with on the occasion of any breakage taking place is the amount of money which we have there in securities, which may be converted into money at the moment. The cable may be in perfect working order, as I have said, to-day: our affairs never looked brighter than they are to-day; but to-morrow the cable may be broken, and it may cost a large sum of money to put it in order. I have told you, in order that you may judge fairly, that since the beginning of this Company we have paid £250,000 in repairs. It is a great uncertainty. Surely we should be wrong, as prudent men, not to keep sufficient money under our control to enable us to make these repairs. I think, gentlemen, that what we have put before you is not unreasonable. As to the suggestion made by Mr. Marcus, I am quite prepared when I return to our board to discuss this question. We have got a certain expression of opinion here to-day, but I am bound to say that the expression of opinion is only from such a very small portion of the shareholders that we should require to get a much larger expression of opinion before we could be induced to change our policy. A Shareholder: For shame! I am surprised. Another Shareholder: We are a representative body here. The Chairman: With these few remarks I will now put the resolution to the meeting. A Shareholder: I think the amendment should be put to the meeting first. The Chairman said that the amendment could not be put as was no: in accordan ce with the articles of association. Mr. Newton: I put it as a recommendation. I should ilike to hear the article read, if the solicitor will kindly read it. The Solicitor: The article is this: "No larger dividend shall be paid than is recommended by the board." Mr. Marshall: It is a recommendation to this meeting. Mr. Newton: It cannot alter the vote we give to pass a recommendation. Mr. Marshall: I am legally advised, Mr. Chairman, that I can move an amendment to the resolution. The Chairman said that if the Company wanted any alteration they must take steps before the meeting and then they would be in order. He could not rule the meeting in order when it was out of order. If there was anything they objected to they must take their preparation before the meeting. Mr. Newton asked what shareholder would spend the money necessary. He had intended doing so at one time, but he found it would cost £50 to alter the articles of association. He stated at the time, and published the statement in the *Times* with his name at the foot of it, that the directors had blockaded themselves behind the articles of association, which were not right and fair to the Company. It was not right to ask the shareholders to spend £50 to gain an expression of opinion at this meeting. Mr. M'Laren Smith: I do not see what the meeting was called for if we cannot pass any amendment. The Chairman: Gentlemen, I am sorry that any discussion should take place on this matter. I think you are injuring your property, that is all I can say about it. You must pass this resolution; that connot be altered; then if any gentleman desires to move a recommendation to the directors that an increased dividend should be paid at a future time there is no harm in that. The resolution was then put and carried unanimously. Mr. Marshall subsequently moved that the directors take into consideration the traffic receipts from to time, with a view of increasing the dividend. The Chairman: We have no objection whatever to that recommendation being moved and seconded; none whatever. The motion was seconded by Mr. Newton and Mr. M'Laren Smith, and adopted. The Chairman said that no one would rejoice more than he would to see the dividends increased, but he would rejoice still more to see that increase resting upon a basis which would prove permanent. Mr. Bevan and Mr. Earle were re-elected directors. Mr. Baynes called attention to the fact that Baron d'Erlanger had retired from the directorship, and asked whether that would alter the remuneration the board received. The Chairman said that on a previous occasion there was an expression of opinion that there were more directors than were necessary. He then stated that whenever there was an opportunity for a director to retire the board would avail themselves of that opportunity to reduce the amount of remuneration by the amount that the director received. (Hear, hear.) A vote of thanks to the chairman brought the proceedings to a close.

AT a meeting of the Directors of the West India and Panama Telegraph Company, held on April 14th, after deciding to place £2,000 to reserve it was resolved to recommend to the shareholders at the approaching meeting that a dividend at the rate of 6 per cent. per annum be declared on the first and second preference shares for the half-year ending 31st December last, carrying £1,017 to the current year.

THE SUBMARINE CABLES TRUST announce that the coupons which become due on 15th instant, will, under authority of the Court of Chancery, be paid on that date by Messrs. Glyn, Mills, and Co., of Lombard Street. At the last annual meeting a resolution was passed authorising the formation of a limited liability company to take over the property of the trust and carry out its objects. On preparing the articles of association of the proposed new company so many legal difficulties presented themselves, that finding

these insurmountable the trustees abandoned the idea, and having been advised that there was a reasonable probability of the decision of the Master of the Rolls being reversed on appeal, they authorised the necessary steps to be taken to this end. The trustees regret that the large number of cases on record having a prior right to adjudication in the Court of Appeal will involve considerable delay, but they have directed every effort to be made to expedite the hearing.

THE Directors of the Direct United States Cable Company, Limited, have resolved upon the payment of an interim dividend of five shillings per share, being at the rate of 5 per cent. per annum for the quarter ending 31st March, 1880, such dividend to be payable on and after the 15th May next.

Mr. H. WEAVER, the Managing Director of the Anglo-American Telegraph Company, informs us that their cable broken off the coast of Ireland on the 2nd inst. was repaired on the evening of the 15th, and is now in perfect working order and condition.

IT is announced by the Telegraph Construction and Maintenance Company that the tenth distribution, at the rate of 2s. 3d. per £5 certificate of the Second Bonus Trust, will be paid on the 1st of May.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.—Report of the directors to be presented to the thirteenth half-yearly general meeting, for the half-year ended 31st December, 1879, states that the revenue for this period amounted to £77,504 15s. 8d.; the working expenses to £11,494 5s. 2d., leaving a balance of £66,010 10s. 6d.; to this is added £1,600 4s. 7d., brought forward from the 30th June, 1879, making a total of £67,610 15s. 1d. After deducting income tax, £889 2s. 2d., there remains a balance of £66,721 12s. 11d. First and second interim dividends amounting to £32,500 have been distributed, leaving the sum of £34,221 12s. 11d. to be carried forward. The Company's cables continue in good working order. The shareholders are aware that for some time past the directors have been endeavouring to obtain certain variations of the working agreement with the Western and Brazilian Telegraph Company, the main point being an alteration of the proportions of gross receipts exchanged between the two companies. The board were advised by eminent counsel that this matter was within the powers of the arbitrator to be appointed under the agreement, but the Western and Brazilian Company disputed the claim, and the question has now been decided by the Queen's Bench Division of the High Court of Justice and by the Court of Appeal in favour of the Western and Brazilian Company. Two other of the claims of this company have been assented to, and the Court has appointed an arbitrator to decide upon the only remaining question. It is probable, however, that an arrangement will be come to on this head, and the expense of arbitration avoided. The summary of total traffic receipts shows that for the year 1874-5, they were £128,461; 1875-6, £129,038; 1876-7, £131,507; 1877-8, £134,003; 1878-9, £139,654, and for six months ending 1879, £77,177.

The following are the final quotations of telegraphs:—Anglo-American, Limited, 60¼-61¼; Ditto, Preferred, 89½-90½; Ditto, Deferred, 34-34½; Brazilian Submarine, Limited, 7¾-8; Cuba, Limited, 9¾-10¼; Cuba, Limited, 10 per cent. Preference, 16¼-16¾; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 10½-11; Direct United States Cable, Limited, 1877, 11⅜-11⅝; Scrip of Debentures, 100-102; Ditto, £25 paid, par-2 pm.; Eastern, Limited, 8¾-9; Eastern 6 per cent. Preference, 12¼-12¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 102-105; Eastern 5 per cent. Debentures, repayable August, 1887, 102-104; Eastern, 5 per cent., repayable Aug., 1899, 102-104; Eastern Extension, Australasian and China, Limited, 8⅞-9⅛; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 101-103; Ditto, registered, repayable 1900, 102-105; German Union Telegraph and Trust, 8¾-9¼; Globe Telegraph and Trust, Limited, 5¾-6; Globe, 6 per cent. Preference, 11½-11¾; Great Northern, 9⅞-10⅛; Indo-European, Limited, 24-25; London Platino-Brazilian, Limited, 6-6½; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 10½-11½; Reuter's Limited, 10-11; Submarine, 230-240; Submarine Scrip, 2-2¼; West Coast of America, Limited, 2-2¼; West India and Panama, Limited, 1⅞-2⅛; Ditto, 6 per cent. First Preference, 7¾-8¼; Ditto, ditto, Second Preference, 7-7½; Western and Brazilian, Limited, 8-8¼; Ditto, 6 per cent. Debentures "A," 100-103, Ditto, ditto, ditto, "B," 100-103; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 33¾-34¼; Ditto, 6 per cent. Bonds, 104-108; Ditto, Second Bonus Trust Certificates, 3⅛-3⅜; India Rubber Co., 14½-15; Ditto, 6 per cent. Debenture, 103-105.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
March, 1880 ...	*	13,279	3,500	... ...	*	43,374	26,425	16,440	... ...	*	1,775	11,491	6,075
March, 1879 ...	47,550	13,052	3,256	929	15,850	41,255	26,185	15,401	... ...	9,790	3,700	11,688	5,231
Increase	... ...	227	244	... ...	... ...	2,119	240	1,039	... ...	... ...	... ...	... ...	844
Decrease	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	1,925	197	... ...

* Publication of receipts temporarily suspended.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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FIRE ALARMS.

THE authorities of the City of London appear at last to be waking up to the necessity of some system of alarms for summoning aid in case of fire. Whether this is due to the feeling that public opinion will imperatively require something to be done in the matter before long, or to a desire to show that scientific appliances should have opportunities of being tested, or to any other reason, is of little importance; but the fact remains that a too long delayed means of adding to the security of property and of life will now have a fair trial.

Every credit must be given to the authorities in charge of the Metropolitan Fire Brigade for the efficiency to which that department has been brought. The interval between the receipt of the alarm and the despatch of the engines is marvellously small—in fact, could hardly be less; but the same cannot be said of the time occupied between the outbreak of a fire and the announcement of the alarm at the police or fire station. The number of stations in the Metropolis must necessarily be limited, and the distance between the same and the houses over which they keep guard must in many cases be considerable, consequently some more expeditious means of carrying the alarm than the foot messenger is obviously required. As is well known, the Americans have long since fully recognised this, and their system of alarms is very perfect.

A stimulus will no doubt be given to the matter from the alarming frequency with which disastrous fires have taken place of late in the Metropolis, and it will only want a few cases to take place, as they assuredly will, in which the electric warning will have been of most material use in enabling the progress of fires to be checked at the outset, to cause a considerable extension of the trial systems and their eventual permanent adoption. At present two systems will be under trial, viz., that of Mr. Edward Bright, which was fully described in the number of this journal for Feb. 15th, 1879. The other system is that of the Exchange Telegraph Company, and is like in principle to the one most generally employed in the United States. This system has the advantage that it indicates to the communicator of the alarm whether his signal has been received or not. The signalling apparatus is enclosed in an iron case similar to a postal pillar-box. The erection of these fire alarm boxes at the corners of the streets excites the usual public curiosity, and it is to be hoped that when the systems are set in working order they will prove as valuable as they ought. It is by no means a creditable fact that the Metropolis should have been left for so long a period without such an essential adjunct to the Fire Brigade force; this disgrace seems now likely to be wiped out, and as soon as full scope is given to the system we may hope to see a very considerable diminution in the large and disastrous fires, both to life and property, which are now of such frequent occurrence.

ON ELECTRIC LIGHTING.

By DR. JOHN HOPKINSON, F.R.S., of London.

(SECOND PAPER.)

Read before the Institution of Mechanical Engineers.

Dynamo-electric Machines.—Since the date of the author's former paper in April, 1879,* other observers have published the results of experiments similar to those described by him. These results reduced to a curve, in which the abscissæ represent a current passing through the dynamo-electric machine, and the corresponding ordinates represent the electromotive force of the machine for a certain speed of revolution, when that current is passing through it, show the following results:—It will be found (1) that with varying speed the ordinate, or electromotive force, corresponding to any abscissa or current, is proportional to the speed; (2) that the electromotive force does not increase indefinitely with increasing current, but that the curve approaches an asymptote; (3) that the earlier part of the curve is, roughly speaking, a straight line, until the current attains a certain value, and that at that point the electromotive force has reached about two-thirds of its maximum value. When the current is such that the electromotive force is not more than two-thirds of its maximum, a very small change in the resistance with speed of engine constant, or in the speed of the engine with resistance constant, causes a great change in the current. For this reason such a current, which is the same for all speeds of revolution, since the curves for different speeds differ only in the scale of ordinates, may be called the "critical current" of the machine.

In Germany, Auerbach and Meyer (Wiedemann's Annalen, Nov., 1879) have experimented fully on a Gramme machine at various speeds, and with various external resistances. The resistance of the machine was 0·97 ohms. Their results are summarised in a table at the end of their paper, which gives the current passing, with resistances in circuit from 1·75 to 200 Siemens units, and at speeds from 20 to 800 revolutions per minute. The relation between electromotive force and current, as deduced from some of their observations, showed that at a speed

* *Telegraphic Journal*, May 15th, 1879.

of 800 revolutions the maximum electromotive force is about 76 volts; the critical current, corresponding to a force of about 51 volts, is 6·5 webers, with a total resistance of 7·8 ohms. Up to this point there will be great instability, exactly as was the case in the Siemens machine examined by the author, where the resistance was 4 ohms, and the speed 720 revolutions.

The results of an elaborate series of experiments on certain dynamo-electric machines have recently been presented to the Royal Society by Dr. Siemens. One of the machines examined was an ordinary medium-sized machine, substantially similar to that tried by the author in 1879. It is described as having 24 divisions of the commutator; 336 coils on the armature, with a resistance of 0·4014 Siemens units; and 512 coils on the magnets, with a resistance of 0·3065; making a total resistance of 0·7079 Siemens units = 0·6654 ohms. In this case the maximum electromotive force appears to be probably 76 volts, and the critical current 15 webers, which is the same as in the author's first experiments on a similar machine.

In the summer of 1879 the author examined a Siemens machine of the smallest size. This machine is generally sold as an exciter for their alternate current machine. It has an internal resistance of 0·74 ohms, of which 0·395 is in the armature or helix. The machine is marked to run at 1130 rev. per min. The following table gives, for a speed of 1000 rev., the total resistance, current, electromotive force, and horse-power developed as current. The horse-power expended was not determined.

EXPERIMENTS ON SMALLEST-SIZED SIEMENS DYNAMO-ELECTRIC MACHINE.

Resistance.	Electric Current.	Electromotive Force.	Horse-power developed as current.
Ohms.	Webers.	Volts.	H.-P.
2·634	4·53	13·2	0·08
2·221	10·8	27·0	0·39
1·967	15·1	33·6	0·68
1·784	18·1	36·4	0·88
1·668	19·8	37·2	0·98
1·579	20·6	36·6	1·01
1·503	22·8	39·3	1·20
1·440	24·7	40·0	1·32
1·145	32·2	41·5	1·79

In this case the critical current is 11·2 webers, and the maximum electromotive force, at the speed of 1000 rev., is about 42 volts. The determinations for this machine were made in exactly the same manner as in the experiments on the medium-sized machine, using the galvanometer, but omitting the experiment with the calorimeter (compare Table I., page 249, Proceedings, April, 1879).

The time required to develop the current in a Gramme machine has been examined by Herwig (Wiedemann, June, 1879). He established the following facts for the machine he examined. A reversed current, having an electromotive force of 0·9 Grove cells, sufficed to destroy the residual magnetism of the electro-magnets. If the residual magnetism was as far as possible reduced, it took a much longer time to get up the current than when the machine was in its usual state. A longer time was required to get up the current when the external resistance was great than when it was small. With ordinary resistance the current required from ¾ second to 1 second to attain its maximum.

Brightness of the Electric Arc.—The measurement of the light emitted by an electric arc presents certain peculiar difficulties. The light itself is of a different colour from that of a standard candle, in terms of which it is usual to express luminous intensities. The statement, without qualification, that a certain electric lamp and machine give a light of a specified number of candles, is therefore wanting in definite meaning. A red light cannot with propriety be said to be any particular multiple of a green light; nor can one light, which is a mixture of colours, be said with strictness to be a multiple of another, unless the proportions of the colours in the two cases are the same. Captain Abney (Proceedings of the Royal Society, March, 1878) has given the results of measurements of the red, blue, and actinic light of electric arcs, in terms of the red, blue, and actinic light of a standard candle. The fact that the electric light is a very different mixture of rays from the light of gas or of a candle, has long been known, but has been ignored in statements intended for practical purposes.

Again, the emission of rays from the heated carbons and arc is by no means the same in all directions. Determinations have been made in Paris of the intensity in different directions, in particular cases. If the measurement is made in a horizontal direction, a very small obliquity in the crater of the positive carbon will throw the light much more on one side than on the other, causing great discordance in the results obtained.

If the electric light be compared directly with a standard candle, a dark chamber of great length is needed—a convenience not always attainable. In the experiments made at the South Foreland by Dr. Tyndall and Mr. Douglass, an intermediate standard was employed; the electric light was measured in terms of a large oil lamp, and this latter was frequently compared with a standard candle.

Other engagements have prevented the author from fairly attacking these difficulties; but since May, 1879, he has had in occasional use a photometer with which powerful lights can be measured in moderate space. This photometer consists of a lens of short focus, which forms an image of the powerful source of light which it is desired to examine. The intensity of the light from this image will be less than that of the actual source by a calculable amount; and when the distance of the lens from the light is suitable, the reduction is such that the reduced light becomes comparable with a candle or a carcel lamp. Diaphragms are arranged in the cell which contains the lens, to cut off stray light. One of these is placed at the focus of the lens, and has a small aperture. It is easy to see that this diaphragm will cut off all light entering from a direction other than that of the source; so effectually does it do so that observations may be made in broad daylight on any source of light, if a dark screen be placed behind it. A long box about 7 ft. length, is lined with velvet—the old-fashioned dull velvet—not that now sold with a finish, which reflects a great deal of the light incident at a certain angle. This box serves as a dark chamber, in

which the intensity of the image formed by the lens is compared with a standard light, by means of an ordinary Bunsen's photometer sliding on a graduated bar.

Mr. Dallmeyer kindly had the lens made for the author: he can therefore rely upon the accuracy of its curvature and thickness; it is plano-convex, the convex side being towards the source of light. The curvature is exactly 1 in. radius and the thickness is 0·04 in.; it is made of Chance's hard crown glass, of which the refractive index for the D line in the spectrum is 1·517. The focal length f is therefore 1·933 inch.

Let u denote the distance of the source of light from the curved surface of the lens, and v the distance of the image of the source from the posterior focal plane. Neglecting for the moment loss by reflection at the surface of the glass, the intensity of the source is reduced by the factor $\left(\frac{v}{u}\right)^2$. But $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$, or $v=\frac{uf}{u-f}$; hence the factor of reduction is $\left(\frac{f}{u-f}\right)^2$. The effect of absorption in so small a thickness of very pure glass may be neglected; but the reflection at the surfaces will cause a loss of 8·3 per cent., which must be allowed for. This percentage is calculated from Fresnel's formulæ, which are certainly accurate for glasses of moderate refrangibility, and for moderate angles of incidence.

Suppose, for example, it is required to measure a light of 8,000 candles; if it be placed at a distance of 40 in., it will be reduced in the ratio 467 to 1, and becomes a conveniently measurable quantity. By transmitting through coloured glasses both the light from an electric lamp and that from the standard, a rough comparison may be made of the red or green in the electric light with the red or green in the standard.

A dispersive photometer, in which a lens is used in a somewhat similar manner, is described in Stevenson's "Lighthouse Illumination;" but in that case the lens is not used in combination with a Bunsen's photometer, nor with any standard light. Messrs. Ayrton and Perry described a dispersive photometer with a concave lens, at the meeting of the Physical Society, on 13th December, 1879 (Proc. of the Physical Society, vol. iii., p. 184). The convex lens possesses however an obvious advantage in having a real focus, at which a diaphragm to cut off stray light may be placed.

Efficiency of the Electric Arc.—To define the electrical condition of an electric arc, two quantities must be stated—the current passing, and the difference of electric potential at the ends of the two carbons. Instead of either one of these, we may, if we please, state the ratio $\frac{\text{difference of potential}}{\text{current}}$, and call it the resistance of the arc, that is to say, the resistance which would replace the arc without changing the current. But such a use of the term electric resistance is unscientific; for Ohm's law, on which the definition of electric resistance rests, is quite untrue of the electric arc; and on the other hand, for a given material of the electrodes, a given distance between them, and a given atmospheric pressure, the difference of potential on the two sides of the arc is approximately constant. The product of the difference of potential and the current is of course equal to the work developed in the arc; and this, divided by the work expended in driving the machine, may be considered as the efficiency of the whole combination. It is a very easy matter to measure these quantities. The difference of potential on the two sides of the arc may be measured by the method given by the author in his previous paper, by an electrometer, or in other ways. The current may be measured by an Obach's galvanometer, by a suitable electrodynamometer, or best of all, in the author's opinion, by passing the whole current, on its way to the arc, through a very small known resistance, which may be regarded as a shunt for a galvanometer of very high resistance, or to the circuit of which a very high resistance has been added.

It appears that with the ordinary carbons and at ordinary atmospheric pressure no arc can exist with a less difference of potential than about 20 volts; and that in ordinary work, with an arc about ¼ in. long, the difference of potential is from 30 to 50 volts.

The success of burning more than one regulating lamp in series depends on the use in the regulator of an electro-magnet, excited by a high resistance wire connecting the two opposed carbons. The force of this magnet will depend upon the difference of potential in the arc, instead of depending, as in the ordinary lamp, upon the current passing. Such a shunt magnet has been employed in a variety of ways. The author has arranged it as an attachment to an ordinary regulator: the shunt magnet actuates a key, which short-circuits the magnet of the lamp when the carbons are too far parted, and so causes them to close.

In conclusion the author ventures to remind engineers of the following rule for determining the efficiency of any system of electric lighting in which the electric arc is used, the arc being neither exceptionally long nor exceptionally short. Measure the difference of potential of the arc, and also the current passing through it, in volts and webers respectively; then the product of these quantities, divided by 746, is the horse-power developed in that arc. It is then known that the difference between the horse-power developed in the arc and the horse-power expended to drive the machine must be absolutely wasted, and has been expended in heating either the iron of the machine or the copper conducting wires.

ON THE MECHANICAL TRANSMISSION OF SOUND BY WIRES, AND ON SIMPLE FORMS OF MICROPHONE RECEIVERS.

By W. J. MILLAR, C.E., Sec. Inst. Engineers and Shipbuilders in Scotland.

(Continued from page 153.)

SIMPLE FORMS OF MICROPHONE RECEIVERS.

WHEN carrying out some experiments with the microphone, having a galvanometer in circuit, it occurred to the author that, since the wires during mechanical transmission, as already described, must be in a state of varying strain from the vibratory actions affecting them, then, if the needle of the

galvanometer were fixed, a state of strain would be induced on the passage of the current, and that this strain of the particles would elicit sounds. To test this, a few yards of covered copper wire were passed lengthwise along the flat sides of a small bar magnet, and connected with a battery. On placing the magnet to the ear, sounds were at once detected on making and breaking contact. These sounds were intensified by placing the magnet on the lid of a pasteboard box; or, better still, on a piece of tin. With this simple arrangement conversation, singing, and musical sounds were readily transmitted.

Various forms of receiver on this principle have been devised (see figs. 1, 2, 3, 4, 5), consisting of—

(1) Arrangements of bar magnets, as described, having from 6 to 12 yards of covered wire, and placed in wooden and tin boxes.

(2) A horse-shoe magnet, having a few turns of covered wire passed lengthwise along one of its limbs, and a tin plate placed on their flat sides. With these arrangements talking, singing, &c., were readily transmitted.

(3) A few turns of wire passed round a tin plate, the latter being allowed to rest by attraction on the flat sides of the limbs of the horse-shoe magnet, placed on the edges of a tin box that the sounds were rendered more generally audible.

A single Leclanché cell was used throughout the experiments enumerated.

From the experiments made, the author believes that the sounds originate in the magnet, and that the iron plate, by extending the magnetised surface, reinforces these sounds. Thus, when a large tin plate was placed on the horse-shoe magnet, the vibrations could be detected by hand as a tremor through the metal. Clearness of articulation depended more on the action of the carbon transmitter than upon any nicety of arrangement of the receiver, the latter depending wholly upon the action between the magnetised body and the flow of the current.

The Count du Moncel, in referring to some of the author's experiments in his work on "The Telephone," expresses the opinion that a vibrating diaphragm is not necessary for the reproduction of speech, and that where a diaphragm is used the vibratory movements may arise from the act of magnetisation in the centre of the diaphragm.

From various circumstances the author has been unable to extend his experiments, but he believes

FIG. 1.

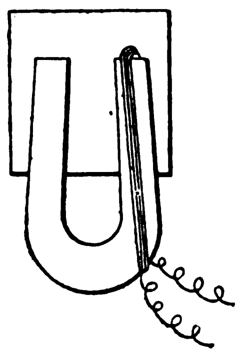


FIG. 2.

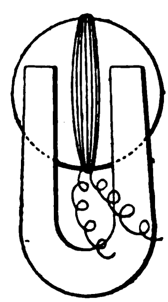


FIG. 3.

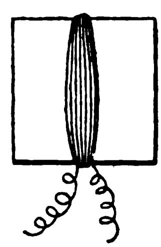


FIG. 4.

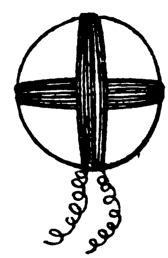


FIG. 5.

the tin plate and its wire being placed in various positions. It was found that sounds were transmitted by this arrangement, and that the tone varied with the position of the tin plate. It was also found that pieces of wood or cardboard could be used instead of the tin plate in this experiment.

(4) Interesting results were got by simply taking a tin plate and wrapping a few yards of wire round it (no magnet being used). Sounds were distinguished on breaking contact, and, when connected with the carbon transmitter, musical and other sounds, such as singing, &c., could be heard; talking could just be detected. The sounds were in this case low, but the effects were quite the same as when the magnet was used.

When using a magnet the strongest sounds were observed near its poles; the tone was deeper near the centre.

Square pieces of tin or ferrotype gave fully stronger sounds than round ones. The plates were allowed to lie as close to the magnet as the magnetic attraction induced them, and in some cases were clamped down.

It was found when the magnetic receivers were that the record of the results obtained will be of interest to the members of the Society, who have so courteously offered him the opportunity of placing them at their disposal.

Since reading the paper the author has made some additional experiments upon the mechanical transmission of sound with wires arranged as in some of the recorded experiments, but without any disc or vibrating flat surface at the sending extremity of the line; and it was found that speaking, singing, and musical sounds could be readily transmitted in this manner. In the case of transmission of speech, the speaker spoke to the wire and close to it; the musical instrument, however, was about twelve feet from the wire. It was also found that the ticking of a watch could be very distinctly heard; the watch simply resting on the wire. From these experiments the author believes that a great part at least of the action of strained wires, as used in buildings for the improvement of the acoustics, is explained by the wires picking up the sounds, and transmitting them to other parts of the building, where their motions either become absorbed, or they cease to have much effect upon the air or parts of the building in their vicinity.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

IX.

(Supplement to Article I.)

THE DROP HANDLE SINGLE NEEDLE INSTRUMENT.

AMONGST the English railway companies the use of the "Drop Handle" Single Needle Instrument as a speaking apparatus is universal; in the Postal Service it is also used, but to a limited extent. The extremely small liability of the instrument to get out of order renders it particularly suitable for railway purposes, and many thousands are consequently at present in use.

The apparatus consists of a commutator worked by a drop handle, and a dial like in every respect to those employed with the "Tapper" single needle.

The commutator at present employed is precisely similar in principle and action to the one used when the single needle instrument was first introduced—nearly 40 years ago. That it should have continued so long in use without alteration is a proof of its suitability for the purpose, and, indeed, it would be difficult to imagine a better design for effecting the object in view.

The general principle of the commutator will be seen from fig. 42.

d is a hardwood cylinder, mounted on an axis, *k*, to which is attached the drop handle seen in figs. 43 and 44. Into the cylinder are screwed firmly two short brass rods, *c*, *e*, so that they are insulated from one another; the top rod, *c*, is connected to the battery terminal, Z, and the rod, *e*, to the battery terminal, Y, which latter corresponds to C in the tapper instrument. s_1, s_2 are curved steel springs, fixed upright to the base of the instrument; the upper ends of these springs normally rest against a brass "bridge," *b*, so that metallic connection is made between the two.

The lower ends of the springs are bent up at *g* and *h*, as shown; s_1 is connected with the left-hand bottom terminal of the dial board (which terminal corresponds to B in the tapper instrument), and s_2 is connected to terminal B.

Action of the Commutator.

The action of the apparatus is as follows:—

Supposing the cylinder to have a right-handed angular movement given to it by means of the handle, then the rod, *c*, presses against the spring, s_1, and moves the end of the latter away from the bridge, *b*; the Zinc pole of the battery then becomes connected to s_2, and thence with terminal B and the "Down" line. The Copper pole of the battery, being in connection with the rod, *e*, becomes in communication with the lower part, *g*, of the spring, s_1, and thence through the dial with terminal A and the "Up" line.

If the handle be turned in the reverse direction to the foregoing, then the rod, *c*, presses away the spring, s_1, from the bridge, *b*; thus the Zinc pole of the battery becomes connected through *c* and s_1, and through the dial, with the "Up" line, whilst the Copper pole becomes connected through *e* and *h* with terminal B and the "Down" line; thus the direction of the current becomes reversed.

If, when the handle is at rest in its vertical position, another station sends signals, then the course of the current will be, say, from terminal B through the spring, s_2, the bridge, *b*, the spring, s_1, and thence through the dial to terminal A and the "Up" line.

The connections shown are those for an "Intermediate" station. If the instrument is at an "Up" station, then terminal A must be put to earth, terminal B being connected to line. If the instrument is at a "Down" station, then terminal A must be put to line, and terminal B to earth.

Construction of the Commutator.

As in the "tapper," there are several points which must be attended to in the design of the drop handle instrument, so that it may work with certainty, and without jarring. The arrangement of the various parts may be seen from figs. 43, 44, 45, and 46.

The cylinder to which the rods, *c* and *e*, are screwed is formed of hardwood, covered with a brass cylinder, divided into two halves; into the half near the back of the instrument, the rod, *c*, is screwed, and into the other half the rod, *e*, is similarly secured. A flexible connection is made between *c* and terminal Z, by means of an insulated copper strand wire, *r* (fig. 43); one end of this is secured by a screw to the half of the brass cylinder into which *c* is screwed, the wire then makes a turn loosely round the cylinder and finally is secured to the brass column, *i*, which latter is connected to terminal Z, thus a perfectly flexible and reliable connection, which in no way impedes the regular movement of the cylinder, is secured. The rod, *c*, which is screwed into the second half of the brass cylinder, is connected in a similar way with terminal Y by the strand wire *z* (fig. 44).

The lower ends, *g*, *h*, of the springs, s_1, s_2, against which the rod, *e*, banks when the cylinder is rotated to the right or left, are not solid blocks of metal; if this were the case, every time *e* struck against them a disagreeable jar and rattle would be produced. The actual construction of these portions of the apparatus will be seen from fig. 45, which represents spring, s_2, and its attachments. P, P, is a brass cock which is screwed firmly to the base of the instrument; to one portion of P, the lower end of the spring s_2 (which must be well tempered) is secured. A curved spring, *t*, has one end secured at *x*, and then makes a turn round the lower end of s_2 without touching it, and finally has its other end brought round to the position shown at *h*; between *h* and *x* a block of leather is set which is gripped between *h* and *x* by the pressure of the curved spring *t*; *h* is then the surface against which the rod *e*, strikes when the cylinder is moved, and as the backing is of leather but very little jar is produced. Fig. 45 may seem a somewhat complicated device for producing the required object, but in reality it is a very good way of effecting it. It might be suggested that the spring, *t*, could be dispensed with, and a piece of metal be simply cemented to *w*; this, however, would never do in practice, as no cement would stand the constant jar, and besides it would leave *h* disconnected from P and the spring s_2.

The spring, s_1, and its attachments are of course fashioned in a similar way to the foregoing.

As it is a point of great importance that the rod,

c, should stand clear of the springs, s_1 s_2, when the cylinder is in its normal position, some device is necessary to effect this object, which the weight of the drop handle itself would not do with certainty. Fig. 46 shows how this requirement is effected; the axle of the cylinder nearest the back of the instrument is prolonged through its bearing and is filed square; this square part is gripped between two strong springs, *n*. If now the cylinder be rotated, as shown, then the tendency of the edges of the squared axle is to open the springs, and consequently when the drop handle is released the pressure tends to bring the cylinder back to its normal position.

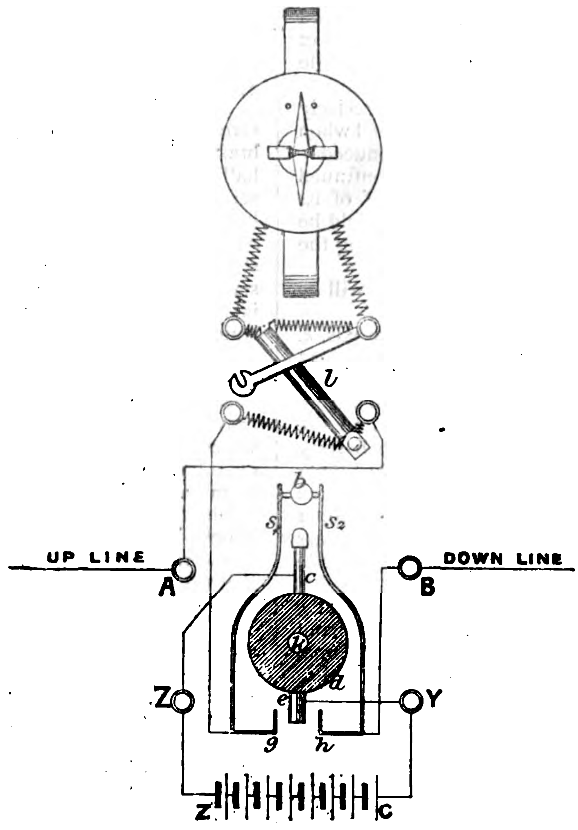


FIG. 42.

The axle to which the drop handle is secured is very firmly fixed, in fact, forms part of the cylinder into which the rod, *e*, is screwed; this is very important, as the violent mechanical action to which the handle is subjected might otherwise cause it to twist out of position.

Faults.

From its solid construction, the drop handle single needle instrument very rarely becomes faulty. The flexible wire connections sometimes break, but from their length and the smallness of the angular movement of the cylinder, this is a very rare fault. The springs, s_1 s_2, are also liable to break, but, again, this very rarely happens. Beyond these two faults, the instrument is practically secure in its action. It is perhaps needless to say, that dirty contacts never occur, the comparatively violent action under which the instrument necessarily works prevents anything of the kind from arising.

SPAGNOLETTI'S SINGLE NEEDLE DIAL.

These dials are largely employed in the railway instruments, and also to some extent in the Postal apparatus. In point of efficiency they are superior to the Varley dial, as with the same current they give much more powerful signals, or equally powerful signals with a less current. A perspective view of the dial with the coils removed is shown by fig. 47. M, M_1 are strong horseshoe magnets with their similar poles turned to one another; the poles are in close proximity to the ends of the axis upon which is fixed the compound soft iron needle, *a*, *b*; this needle is formed in two halves, the upper half being really a prolongation of the right-hand half of the axle, bent at right angles to the latter; similarly the lower half of the needle is a right-angled prolongation of the left-hand half of the axle. The two portions are brazed together, so that the two halves of the axle are in a straight line, whilst the two halves of the needle are similarly in a straight line, but at right angles to the whole axle; a piece of brass, *c*,

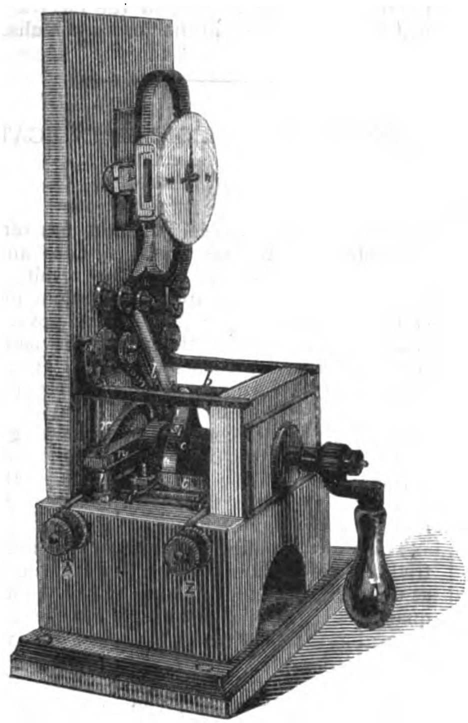


FIG. 43.

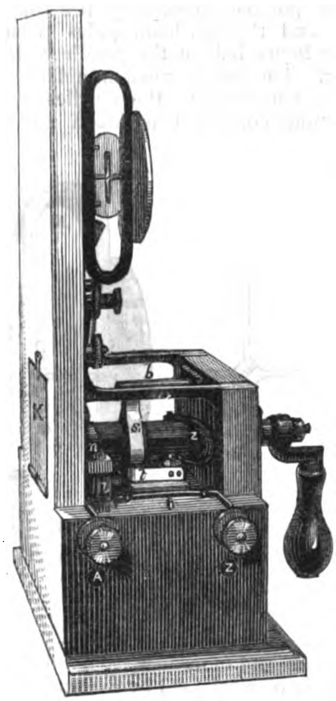


FIG. 44.

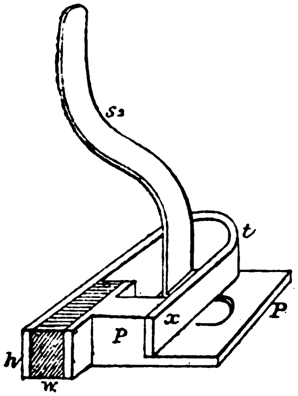


FIG. 45.

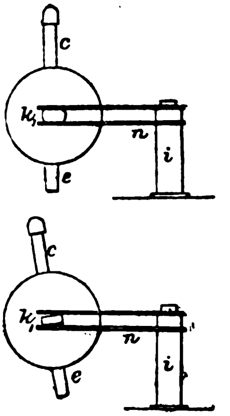


FIG. 46.

between the two elements of the half axles and needles, magnetically insulates the two halves; thus it happens that the right-hand poles of the horseshoe magnets polarise powerfully the top half of the needle, and the left-hand poles polarise powerfully the lower half of the needle with an opposite polarity. The whole needle, in fact, is similar in magnetic condition to the needles in the original Wheatstone coils, but is much more powerfully

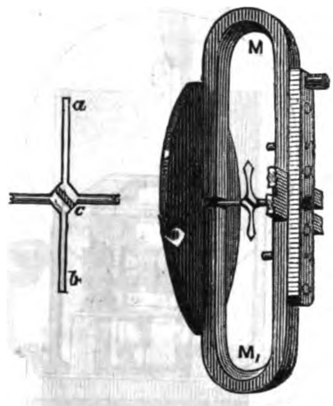


FIG. 47.

magnetised, and moreover is not liable to be demagnetised or weakened by external influences.

The general construction of the coil, viz., its framework, attachment of coils, &c., is similar to that in the Varley coil (article I., page 24).

The instrument indicated by figs. 43, 44, is fitted with a Spagnoletti dial, one of the coils being removed to show the needle.

CURIOUS MAGNETIC EXPERIMENT.

IN the fifth session of the Physical Society of the St. Petersburg University, held on the 27th of December, 1879, Professor Leinstrein (from Gelsinforce) made the following communication on the cause of terrestrial magnetism.

The results of his experiments on the subject were printed in the Swedish language in 1877. In these experiments he found that a ring-shaped insulator which has a rotatory movement of high velocity imparted to it, and within which an iron bar is placed, imparted magnetism to the latter; in fact, acted like a voltaic current.

According to a theory of M. Edlund, this magnetism is explained by the movement of the ether existing in the insulated body. Arguing from this theory, the author proves that the rotation of an iron bar within an insulating body must produce magnetism within the bar. Applying this conclusion to the earth as a paramagnetic body, Professor Leinstrein shows that the earth must be magnetised through its rotation on its axis in the ethereal space, just as is actually the case.

The arterial distribution of the magnetism can be explained through the earth's movement around the sun.

Magnetic perturbations have their origin, in the the opinion of the author, in the electric currents which are originated in the aurora borealis.

AN ELECTRICAL SPEED INDICATOR.*

By H. R. KEMPE.

THE design of a Speed Indicator has often been attempted by various mechanicians, and many ingenious devices have been the result. One of the simplest forms of apparatus for the purpose is constructed on the principle of the governor of a steam engine, in which the angular deviation of the weighted arms represents the speed at which the instrument is turning. Such an instrument has been designed by Messrs. Elliott Brothers. Another form of instrument consists of a vertical glass tube partly filled with oil or coloured liquid, and which is rotated on its axis; the action causes the liquid to rise in the tube, the height to which it ascends representing the velocity.

The scales for such instruments are graduated by trial, and are not always correct under all conditions, as they are dependent to some extent upon variable quantities. It is also necessary that the indications be read at the place where the speed to be measured takes place.

In the instrument which I have to show you this evening the indications given are absolutely accurate under all conditions, as the apparatus is regulated by means of a clock, and, moreover, the instrument can be placed at any distance from the engine or apparatus whose speed it is required to indicate.

It would be impossible without elaborate diagrams to explain the action of the apparatus, but I will point out that the indicating hand points at every minute to the number of revolutions which the machine to which it is electrically connected has made during that minute, and the hand remains stationary at that indication till the next minute, when it advances or recedes according as the speed has increased or decreased during that minute. The apparatus is worked by a step by step motion, which moves a ratchet wheel forward one tooth at a time at each revolution made by the engine, the latter sending a current at each revolution. At the end of a minute the indicating hand is unlocked, and moves through the same angle which the ratchet has been turned through; the hand is then again locked, and the ratchet wheel allowed to run back to zero, when the same action is again gone through.

To prevent errors which may arise from the engine sending currents whilst the indicating hand is being set by means of the clock, an "accumulator" is employed which accumulates all the currents received from the engine during the time the clock is setting the hand; and then, when the latter action is completed and the rachet wheel returned to zero, the amount accumulated is given

* Read before the Society of Telegraph Engineers, May 13th.

off. By this device, it happens that the sum of all the indications observed on the dial at each minute, during a number of minutes, will always equal the total number of revolutions given by the engine during that number of minutes.

By fixing a small grooved wheel on the axle of the indicating hand with a cord round it to which a pencil is attached, a record can be made of the speed. The size of the sheet of paper on which the indications are drawn can be made without difficulty of convenient dimensions. It need not exceed a size of about two feet by one foot, for indications given during twenty-four hours. On this diagram a line will be traced which will be straight if the engine is working uniformly, and wavy if the speed is irregular, the amount of the deviation showing at once the rate of increase or decrease in the speed.

The uses to which the apparatus, which is shown in front and back view by figs. 1 and 2, can be applied, are obviously numerous. It can be used for indicating the rate at which the paying-out drum of a cable ship is turning, the indicator being placed in the engineer's cabin; the rate at which the ship's engines are working can similarly be indicated.

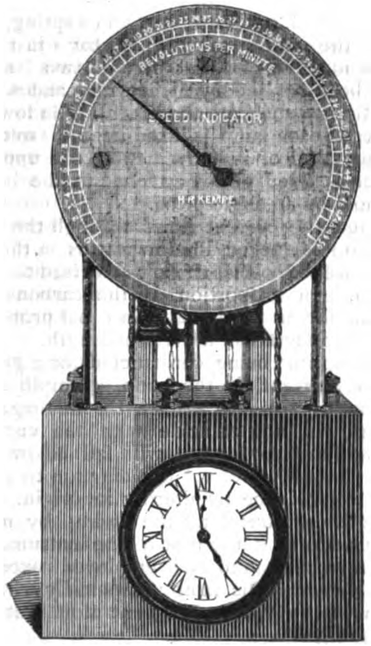


FIG. 1.

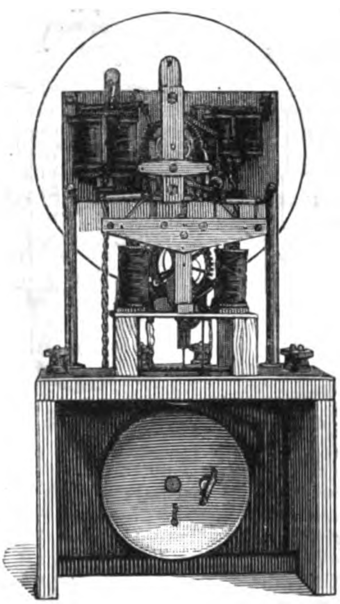


FIG. 2.

NEW ELECTRIC LAMPS FOR TEMPORARY PURPOSES.

THESE small arc lamps are distinguished from other regulators of the same description by the means employed to obtain constant equilibrium by the action of a solenoid and an antagonistic spring.

This equilibrium is obtained by means of a new arrangement invented by M. Emile Reynier, of which the following is a description:—

Let us suppose a bar of soft iron to be completely surrounded by a vertical solenoid, and magnetised by a current of constant strength, and let us progressively cause the iron bar to slide up, for example, in the axis of the system, then the attractive force which hinders the movement of the soft iron bar increases continually until a certain position is reached at which the magnetic attraction is a maximum. If the movement be continued beyond this point the attractive force diminishes, and at length becomes nil, when the bar is completely withdrawn from the coil.

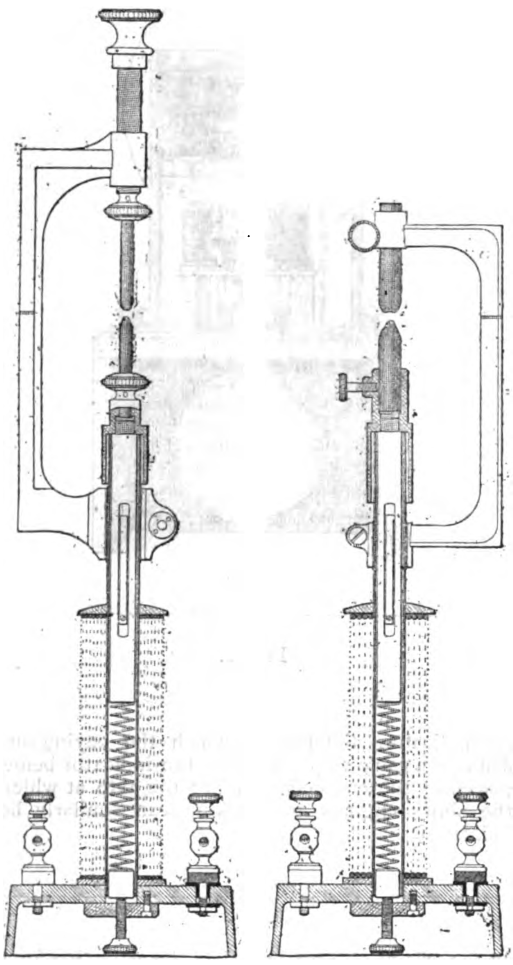
The diagram which would be obtained by taking for abscissæ the distances moved over by the bar, and for ordinates, the magnetic attractions, would form a curve which commences from a point situated above the axis of X, and which rises to a maximum corresponding to the approach of the lower end of

the bar towards the end of the solenoid, and re-descending from the maximum down to the axis of the abscissæ.

We will only consider here this descending part of the diagram. We observe immediately that it forms very nearly a straight line which joins its two extremities.

Now a straight line inclined to the axis of X is precisely the diagram of a spiral stretched spring.

In order to obtain a spring, of which the diagram of tension corresponds to the diagram of the descending curve of the solenoid, it is sufficient to



take a spiral which is pulled to a tension equal in power to the magnetic attraction of the solenoid in question, and which has a length equal to the length of traverse of the bar through the solenoid corresponding to the positions of maximum and minimum attraction.

Such a spring being placed around the soft iron bar, and held at its lower extremity, at a particular point, forms a system possessing the following properties :—

1st. When the current which magnetises the solenoid has a normal intensity, the spring produces equilibrium with the magnetic attraction which sucks in the soft iron bar, so that the position of the latter is above that of the region of maximum attraction.

2nd. When the current is of a less intensity the spring overcomes the magnetic attraction and pushes the soft iron bar upwards to the equilibrium position.

3rd. When the current is of a greater intensity the magnetic attraction overpowers the spring, and sucks in the iron bar downwards to the equilibrium position.

A solenoid, a soft iron bar, and a spring, combined under the conditions which we have just indicated, constitute the essential part of two lamps which have been devised by M. Reynier, and which differ slightly the one from the other. The lower carbon holder of each lamp is fixed upon a soft iron rod, and partakes of its movements; the upper carbon holder is fixed, and is attached to the body of the solenoid by an angle piece.

When the current flows through the apparatus, the iron is sucked in downwards in the solenoid, and descends so that the arc is formed to its normal length. In proportion as the carbons are consumed, the iron bar rises in equal proportion and preserves the arc of a uniform length.

The spring being constructed for a given intensity of current, if the lamp is employed with a current of a different strength, the diagram of the spring will not coincide with the curve of the solenoid's attraction; it will fall below or above. It is possible to reform this diagram to an approximate coincidence by altering its origin. This can be done by stretching the spring by means of a thumb screw at the base of the instrument. This readjustment cannot be employed except within small limits. The lamp works badly with currents of an intensity very different from that for which the spring is constructed.

One form of these lamps is for temporary use in the place of an ordinary regulator. By means of an accessory provision this temporary lamp may be made automatic in its action, immediately that the principal regulator fails from the carbon being consumed, and it will work for twenty minutes, during which time the light will not be interrupted.

A number of these lamps have been in use at various places, for different purposes, since last winter, and have given perfect satisfaction.

The other form of lamp is a model specially adapted for laboratory purposes for throwing objects on the screen; it is constructed for carbons of small diameter, and its bobbin is wound with thinner wire, for currents of a moderate intensity.

The lower carbon being alone movable, the luminous point continually shifts its position. By means of a little movement which can be given from time to time to the upper carbon, the light can be set to a convenient height.

During the burning, the lower carbon holder works automatically in such a way as to maintain the length of the arc constant. The total traverse of the apparatus is equal to three quarters of an hour's burning.

Less complete than the regulators of Duboscq and Serrin, but much less costly, this little lamp answers well for most optical experiments.

A. NIAUDET.

Notes.

MR. J. BERLY, of the "Société Générale de l'Electricité," has continued his experiments in electric lighting on long circuits, and has joined up the two circuits at Victoria Station with that at Blackfriars, making a total circuit of nine miles. Also he has tried five candles joined up with No. 18 wire; these, when compared with a precisely similar five on No. 12 wire, gave equally good results.

IT is stated that the break in the cable of the new French Company is ascertained to be in shallow water about eight miles from St. Pierre, and that the *Pouyer-Quertier* will sail this day week to effect the necessary repairs, which it is expected may be done at once.

THE BRUSH ELECTRIC LIGHT has recently been introduced in the South Kensington Museum.

THE HELIOGRAPH.—We have to thank the heliograph again for an important message received from General Stewart, and announcing the result of an attack on our troops, in which the enemy seems to have suffered severely. The message is dated Camp Ghuzni, April 22nd, and was received at the India Office the following day. It is very probable that the news could not have been brought so speedily by electric telegraph. The heliograph does not require the route to be kept open. The line of communication cannot be cut, for the simple reason that the signalling takes place over the heads of the enemy, and the stations required are but few and far between. A 10-inch mirror, and this is the diameter of the ordinary field heliograph, is capable of reflecting the sun's rays in the form of a bright spot, or flare, to a distance of 50 miles, the signal at this interval being recognisable without the aid of a glass. That is to say, two trained sappers, each provided with a mirror, can readily speak to one another, supposing the sun is shining, with an interval of 50 miles between them, provided their stations are sufficiently high and no rising ground intervenes to stop the rays. The adjustment of the military heliograph is a very simple matter. An army leaves its base where a heliograph station is located, and after travelling some miles desires to communicate with the stay-at-homes. A hill in the locality is chosen, and a sapper ascends with his heliograph, which is simply a stand bearing a mirror swung like the ordinary toilet looking-glass, except that besides swinging horizontally it is also pivoted so as to move vertically as well. Behind the mirror, in the very centre, a little of the quicksilver has been removed, so that the sapper can go behind his instrument and look through a tiny hole in it towards the station he desires to signal. Having sighted the station by adjusting the mirror, he next proceeds to set up in front of the heliograph a rod, and upon this rod is a movable stud. This stud is manipulated like the foresight of a rifle, and the sapper again standing behind his instrument directs the adjustment of this stud until the hole in the mirror, the stud, and the distant station are in a line. The heliograph is then ready to work, and in order to flash signals so that they may be seen at a distance the sapper has only to take care that his mirror reflects the sunshine on the stud just in front of him.—*Daily News*.

THE Brush light, an American invention employing the voltaic arc, is a wonderful success, and bids fair to throw the Jablochkoff candle and all other European contrivances into the shade. It is remarkable that the more successful an electric light is the less public parade it makes; and the Brush lamp has gone into use so quietly that very few are aware of the facts of the matter. About 1,500 of them are now in use. A large number of letters have been received by the writer from cotton-mill and factory owners in this part of the country, in reply to private inquiries as to their experience with the electric light. From these replies, it does not appear that the voltaic arc is always a cheaper means of illumination than gas, but sometimes it is remarkably so. The Pottstown Iron Company report that they have been enabled to run their nail factory all night by means of this light, being the first concern which ever did this. They never could get light enough in their dingy shops at any reasonable cost, but the voltaic arc is ample for the purpose. They do not know what the light costs them, and do not care. Mr. John Wannemacher has just invested about 13,220 dols. in engines, electric machines, and Brush lamps, and he reports that allowing 12 per cent. interest on the investment, and 5 per cent. for wear and tear, he saves 69 per cent. on his bills for lighting. I have received one statement from a large cotton factory in Rhode Island which has been using the voltaic arc light since February, 1876, which is almost incredible. The concern has invested 16,000 dols. in generators and lamps, using 80 lamps in place of about 500 gas-lights. It finds that it now gets a vast increase of light at a cost of only 8,260 dols. a year, whereas it formerly paid out over 28,000 dols. a year for gas. This concern runs all night, and says that the men would not on any account go back to gas-light, because the air of the mill is so much better.—*N. Y. Correspondent Chicago Tribune*.

NEW CABLES.—Duplicate cables have been laid between Singapore and Java, and between Java and Port Darwin. The work has been carried out under the guarantee of a subsidy from the colonies of New South Wales and Victoria, which will make arrangements with the other colonies. In return for the subsidy, Government and press messages are to be carried at reduced rates.

THE use of the electric light on ship-board, both as a means of interior illumination and for the prevention of accidents at night and during foggy weather, is steadily on the increase. The Sound Steamers *Massachusetts* and *Rhode Island*, of the Providence line, have recently been fitted up with Brush lights, by which the halls, cabins, and dining saloons are lighted by electricity. The contract includes an electric head-light, which it is expected will prove extremely valuable in foggy and stormy weather. An exhibition of the use of the new light was given last week on board the steamer *Massachusetts*. Six lights were used, each light being nominally of 2,000 candle-power, and although the saloons were nearly as brilliant as in the day-time, the light was soft and pleasant to the eye. The comparative cost of this light is about equal to that of gas at 30 cents per 1,000 feet.—*Operator*.

WRITING to *Nature* on the subject of Dr. Kerr's discovery of the rotation of the plane of polarisation of light reflected from the pole of a magnet, Mr. J. E. H. Gordon points out how extremely feeble the phenomenon is.

"I used," he says, "an electro-magnet consisting of an iron bar 2 feet 4 inches long, and 2¼ inches diameter, surrounded by 70 lbs. of wire, and excited by 10 Grove cells. The total *double* rotation produced

not by slightly altering the resistance, but by reversing the current, was never more than 26′ (26 minutes of arc). To see this at all with a very delicate Jellett analyser, it was necessary for the observer to increase the sensitiveness of his eye by sitting in total darkness for some 10 minutes before each observation."

The Electric Light in Naval Warfare.—The *Gibraltar Chronicle* of the 5th ult. says:—"On Saturday night at 9.30 o'clock, to the great astonishment of those who were not prepared for it, but who happened to be looking towards the bay, a brilliant light was seen to burst forth suddenly, shooting out a prolonged ray across the water and on to the Rock, which it lighted up in a most vivid manner. This was soon followed by a second similar light at some little distance from the first, and it soon became evident that they were electric lights and proceeded from her Majesty's ships *Minotaur* and *Agincourt*. The practice that followed with these lights, and which was continued for nearly an hour, was interesting in the extreme, for there was not a hole or cranny on the western face of the Rock from the water to the signal station that was not searched out and illuminated as if by magic; nor was there a vessel or a boat in the bay that did not undergo the same minute examination. Owing to the concentration of the light at the instrument necessary to permit of its rays being reflected to a distance, the sphere of its action is unavoidably limited, and it hence becomes necessary to search the water or the shore gradually and methodically, in such a manner as to insure no spot being left unlighted. Thus the drill in itself is intricate, and requires considerable practice. There is one point which cannot fail to strike even the uninitiated, which is that during such time as a vessel displays the electric light she is, while illuminating the batteries of her opponents, an excellent mark for their guns."

The electrical observations taken at the Mountsouris Observatory in the last week in April showed some unusual results; out of the eight readings registered on April 28th not less than six were negative, and on the following day seven were of the same sign.

The shares of the Edison Electric Light Company, par value 100 dols., which at one time sold at 5,000 dols., have since fallen to 1,700 dols. It is stated that many of the extraordinary statements published in regard to the electric light were made solely with a view of enhancing the value of these shares.

The *Natural History Journal* publishes an account of a method of producing facsimiles of plaster-casts in electrolytic copper. The cast is first boiled in stearine, and then blackleaded over; it is then placed in a sulphate of copper bath, and connected to a very weak battery, so that a thin but firm coating of copper is deposited all over the surface. The cast is next baked so as to destroy the cohesion of the plaster particles, which are shaken out in the form of dust, leaving only the copper coating as a shell, the latter is then varnished outside, and again placed in a copper depositing bath, and thickly coated with copper inside, thus solidity is obtained, the outside surface of the shell retaining its sharpness of outline.

The Electrotechnical Society at Berlin now numbers 1,248 members.

Edison's Horseshoe Lamps.—Messrs. Henry Morton, A. M. Mayer, and B. F. Thomas, who recently published in the *Scientific American* an account of some electrical measurements of one of Mr. Edison's horseshoe lamps, and which we reprinted in our last issue, have since published the following additions and corrections to their past article:—

"In reading our first article in print we notice some errors which require correction and some points calling for a more full explanation.

"It was said in the article that the *loss* of weight in one of the electrodes was 1·0624 grammes.

"This was in fact the amount *gained* by the cathode, the loss of the anode being a trifler greater. The gain of weight was, of course, what it was intended to take, so that the error was only in the expression, and not in the process or result.

"In the next place, in the foot note at the end of the same column, it is simply stated that the average of the maximum and minimum lights in azimuths at right angles and in the plane of the loop was taken as the average luminous power of the lamp. Our reason for this, however, was not mentioned, but was, in fact, that we found by measuring the light at every azimuth varying by ten degrees between 0° and 180°, that this was approximately the true expression for the total amount of light emitted. We see from the article of Profs. Rowland and Barker, in the *American Journal of Science*, that they, assuming certain conditions and discussing the same in a mathematical manner, have reached a different result; but as experiment shows this result not to be attained in fact, it is evident that the assumptions on which the mathematical reasoning is based do not include all the conditions present in the experiment.

"Two other sets of experiments, made since those given in our paper of April 17, in which the candle-power of the loop was in its best position, 17·6 and 19·8 candles, corresponding to averages of 11·7 and 13·2 candles respectively, showed a consumption of energy of 0·104 and 0·109 horse-power per lamp, or 9·6 and 9·1 lamps per horse-power. This would give 112 candles and 120 candles respectively per horse-power of electric energy consumed or transformed in the lamp. These results certainly agree very closely with each other and with our former determinations."

A public company, with a capital of 8,000,000 francs, has been formed to work the patent of M. Jamin's electric lamp.

The French Minister of Fine Arts has entered into an agreement with the Jablochkoff Electric Light Company to light the palace during the whole of the two months, commencing May 1st, devoted to the exhibition. The number of lights is about 400, and the motive power about 320 horses. Owing to an accident to the machinery, the use of the system had to be suspended for a few days.

Electricity in the Human Body.—The attention of scientific men has been occasionally directed to the question of the existence of electricity in the human body, and of the capacity of man and other animals to become a store-house, as it were, of electric force; but the subject has not yet been properly investigated, and any new facts bearing on the point are valuable. The matter is one which is of practical importance, in view of the attempts which are being made to press electricity into the service of the medical world as a curative agent. Most people are familiar with the "sparks" which may be produced under certain conditions, by stroking the fur of a cat; and travellers in Canada and other cold dry countries have witnessed the still more remarkable phenomenon of the human body being turned into a conductor of electricity, and the possibility of lighting the gas by merely placing

one's finger—given the necessary conditions of electrical excitement—near the gas-jet without any other agency. Mr. A. W. Mitchinson, the African traveller, who is engaged in writing a narrative of his exploring expeditions in West Central Africa, gives some still more startling facts. He states that one evening, when striking an African native, in a moment of anger, with a cow-hide whip, he was astonished to see sparks produced, and still more surprised to find the natives themselves were quite accustomed to the phenomenon. He subsequently found that a very light touch, repeated several times, under certain conditions of bodily excitement, and in certain states of the atmosphere, would produce a succession of sparks from the bodies of native men as well as native cattle. A lazy nigger, it seems, yielded none of these signs of electricity—a rather unfortunate circumstance for his more active brethren, who may possibly come in for a share of undeserved flogging at the hands of future travellers in search of electrical phenomena among the human race. We are not aware that these facts have been recorded by other travellers, but they certainly deserve thorough sifting by competent observers.—*Globe.*

The King of Spain has signed a decree authorising the laying of a cable between Cuba and Jamaica.

In magnetising steel bars by means of a coil, M. Righi finds that on taking both bars of the same steel and the same diameter, and decreasing their length, a certain length is arrived at which no longer yields any magnetisation; whilst smaller lengths give a permanent polarity opposed to that of the coil.

The cable between Cadiz and the Canary Islands will shortly be sold.

The following notice has appeared in the columns of the daily press:—"Sivewright—Page.—April 27, at St. Andrew's Cathedral, Bloemfontein, South Africa, by the Very Rev. Archdeacon Croghan, assisted by the Rev. Canon Miles, James Sivewright, Esq., M.A., C.M.G., general manager of telegraphs, to Jeannie, third daughter of George Page, Esq., of Bloemfontein."

Systems of electric fire-alarms are now being fixed in various parts of the City.

We have received a copy of a book containing meteorological observations made at the Adelaide Observatory during the year 1878. It is produced under the able direction of Mr. Charles Todd, C.M.G., F.R.A.S., superintendent of telegraphs, South Australia, and is published by the authority of the South Australian Government. The information contained in this work must necessarily prove of great value to those interested in the study of meteorology.

Correspondence.

To the Editor of The Telegraphic Journal.

Dear Sir,—Kindly allow me to point out an error in your remark on my note on "measurements of quantities of current by the craters of positive carbons," brought before the Society of Telegraph Engineers by Professor Ayrton at the last meeting.

The first column of the table in your last week's issue should be headed "Diameter of Craters in inches," instead of "Depths of Craters in inches."

I am, dear sir,
Yours faithfully,
J. W. F. ANDREWS.

5, Mount Street, Margon Road,
Near Charlton, Kent.

Proceedings of Societies.

PHYSICAL SOCIETY.—May 8th.

Sir William Thomson, President, in the Chair.

New members—E. F. Bamher, Dr. E. Obach, R. D. Turner, E. Woods, H. E. Roscoe, H. Watts.

Prof. Minchin, of Cooper's Hill Engineering College, described his further researches in the subject of photo-electricity, brought by him before the last meeting of the Society. He has found that the current in a sensitive silver cell does not always flow from the uncoated to the coated plate. It does when chloride or bromide of silver is used, but when the sensitive emulsion is iodide of silver, and the liquid water tinctured with iodide of potash, the current is from the coated to the uncoated plate. He demonstrated that the current set up by the fall of light on the cell could be sent by wire to a receiving cell, and made to produce a *local* effect on the sensitive plate therein. He also proved that electricity is developed in fluorescent bodies by the action of light, and hopes to show that it is also developed in phosphorescent bodies. Neither heat nor the red rays produce this electricity, but it is the blue and violet rays which do so. The fluorescent silver plates he employed were coated with an emulsion of eocine and gelatine, and kept sensitive for twelve days. They would thus be a permanent source of photo-electricity, did the eocine not tend to leave the gelatine. Mr. Wilson had suggested napthaline red for eocine, as not apt to leave the gelatine, and he had found it give good results.

Dr. O. S. Lodge described certain improvements which he had made in his electrometer key, designed for delicate electrical, and especially electro-static, experiments. Assisted by the British Association, he had made it more convenient, and fitted it into an air-tight case, which could be artificially dried. The contact pins were now of phosphor bronze, gilt, instead of platinum, and the contacts were made by press pins from the outside. Dr. Lodge also exhibited a new inductometer, or modified form of Prof. Hughes' induction balance, combining a Wheatstone balance, and expressly designed for comparing capacities and resistances, especially the resistances of coils having no self-induction. A telephone takes the place of a galvanometer in the bridge, and the current in the primary coil is interrupted by a clockwork make and break. There is one primary coil of fine wire, 3½ ohms in resistance, and two secondaries, one on each side of it, of fine wire, each about 270 ohms. These are fixed, but the primary is adjustable by a screw. Prof. Hughes remarked that he had pointed out in his paper to the Royal Society that the induction balance could be used in this way; and Dr. Lodge disclaimed any novelty in the apparatus beyond its arrangement. Sir W. Thomson added that it was satisfactory to see so serviceable an adaptation of the induction balance to research.

Dr. Hopkinson, Prof. Perry, and Sir W. Thomson offered remarks on the element of time in comparing

discharges from condensers of different dielectrics. Sir WILLIAM said that in 1864 he had made experiments on air and glass dielectrics and found the discharge about the same for the first ½ sec. Prof. ADAMS then took the chair, and Sir W. THOMSON made a communication on the elimination of air from a water steam presssure thermometer, and on the construction of a water steam pressure thermometer. He said it was a mistake to suppose that air was expelled by boiling water because the water dissolved less air when warm than when cold. The fact was due to the relations between the density of air in water, and the density of air in water vapour. There was 50 times more air in the water vapour over water in a sealed tube than in the water below. If this air could be suddenly expelled only $\frac{1}{50}$ part of air would remain, and of this only $\frac{1}{2500}$ in the water, the rest being in the vapour. This suggested a means of eliminating air from water which he had employed with success. It consisted in boiling the water in a tube, and by means of a fluid mercury valve allowing a puff of the vapour to escape at intervals. Sir W. THOMSON also described his proposed new water steam thermometer, now being made by Mr. Casella. It is based on the relations of temperature and pressure in water steam, as furnished by Regnault's or other tables, and will consist of a glass tube with two terminal bulbs like a cryophorus, part containing water, part water steam, and the stem enclosed in a jacket of ice cold water. Similar vapour thermometers will be formed in which sulphurous acid and mercury will be used in place of water or in conjunction with it. For low or ordinary temperatures they will be more accurate than ordinary thermometers.

THE SOCIETY OF TELEGRAPH ENGINEERS.

THE ordinary general meeting of this Society was held on Wednesday, May 12th, Mr. W. H. PREECE, President, in the chair. The minutes of the last general meeting having been read and confirmed, and the list of new and proposed members read, it was announced that the catalogue of the Ronald's library had been completed, and was ready for publication.

Mr. W. H. PREECE then read a paper on "The Destruction by Insects of Gutta-percha in Underground Wires."

For some years past a peculiar decay has been noticed in some of the underground gutta-percha work of the Postal Telegraph Department, which had been difficult to account for. Gutta-percha, as is well known, is a gum exuded from a tree found in tropical climates, called, Isonambra percha. The constituent compounds of gutta-percha are carbon and hydrogen, there being 88 per cent. of the former to 12 per cent. of the latter. It is very seldom, however, that the substance is found pure; oxygen and resins of various natures exist in it as impurities, and the process by which it is sought to purify the gum has the effect of adding other impurities. The chemical composition of the material is the same as that of oil of turpentine.

The discovery of gutta-percha was made about 38 years ago, between the years 1842 and 1843. Dr. Montgomery, when out on one of the islands of the Indian Archipelago, noticed a native with an axe which had a handle of a dark brown flexible material, and he found that the substance could be softened and moulded by the action of hot water. Samples of the substance were brought over to Berlin, and subsequently Faraday examined it, and discovered its high electrical and insulating properties.

As regards durability, the gum was soluble in various liquids, such as, olive oil, benzine, turpentine, &c. It was attacked by ozone, creosote, and other substances. Oxygen also attacked it by a process of rusting, and intermittent exposure to wet and dry rapidly disintegrated and perished the substance. The process of manufacture of the gum caused it to absorb water.

To get rid of the liability of the substance to become perished when applied to insulate wires, Mr. Edwin Clark covered the material with tarred tape, but inasmuch as tar contains creosote, the result was only partially successful.

In 1852, 1853, and 1854, large quantities of wire insulated with gutta-percha were laid down, and as some miles of this deteriorated in various places the subject was investigated by Mr. Edward Highton. This gentleman found that in the underground line between London and Manchester the gutta-percha became decayed wherever the line passed near the roots of oak trees, and he found at such points the surface of the material was covered by a fungoid growth, to which he attributed the mischief; in this surmise, however, he was incorrect.

In all systems of gutta-percha work it is found that where decay takes place, it is at points where air and moisture combined can penetrate, and where changes of temperature take place; this is the case at "flush boxes," and therefore at the present time these boxes are as far as possible hermitically sealed.

Lightning was very destructive of underground work, but this is now prevented by placing lightning protectors at the points where the open work and underground work join. Rats and mice were also very destructive to gutta-percha wires.

The cause of deterioration to which Mr. PREECE particularly desired to draw attention, was that caused by an insect. It was found that the underground work between Chester and Holyhead was in a peculiar state of decay, and on opening up the line and examining the gutta-percha it was seen that the surface was covered with a number of white insects, to which the name of Tempeltonia crystallina had been given. The animal was very small and belonged to the spring-tailed tribe; it was clearly traced that these insects had eaten the substance of the gutta-percha, indeed, microscopical examination proved that the stomach of the insects contained that material.

To get rid of this source of decay, the only course was to entirely bury the wires in hermitically sealed pipes.

Specimens of the insect were exhibited under microscopes.

In the discussion which followed the reading of the paper,

Mr. DAVID BROOKS said, that the amount of gutta-percha insulated wire manufactured in America was very inconsiderable, most of that used being procured from England. Wire insulated with kerite was used to some extent, and with success.

Mr. BROOKS afterwards described his system of underground work, a full description of which has been given in the number of this Journal for Dec. 1st, 1879. Mr. BROOKS stated that when a large number of wires were used for telephonic purposes all bunched together, the effect of induction was very small if all the wires were in use—that is to say, if they all had earth connections. He said that if a number of wires existed in a cable, and only two were in use, the others having their ends insulated, then the induction between the two wires in use was very powerful; but as each of the other wires was put to earth, either direct or through other telephone instruments, the effect of the induction at once became reduced.

Mr. TRUMAN considered that the insect which destroyed the gutta-percha did not exist because the gum

was present, but because it was laid in localities where the vegetable matter around was favourable to the existence of the species. He stated that as regards deterioration by climatic causes, &c., he had completely discovered the cause and remedy, but was not prepared at the time to publicly announce them. Everything depended upon the process of manufacture.

Mr. LATIMER CLARK could corroborate the statement that the decay was due to an insect. As regards general deterioration, this was entirely prevented by keeping the gutta-percha immersed in water, and in tropical countries, where cables landed the leading-in portion of the cable was brought through a pipe which was kept constantly filled with water from a small reservoir, this completely preserved the gutta-percha. He had himself attempted to arrest the progress of decay in gutta-percha wires, using tarred and painted tape, but the success obtained was only partial.

Mr. FLEETWOOD stated that it was quite a mistake to suppose that the faults in the underground work of the Metropolitan district were due to joints. In the last three years he had not had ten cases of faults due to this cause; the decay was solely due to action of air and moisture at the flush boxes. Faults in joints were caused by the use of Chatterton's compound; since the use of this had been discontinued the joints seldom, if ever, went bad. By packing and cementing the flush boxes, and clothing the wires at those points with canvas, the deterioration was prevented. He considered that the real cure for the evil was to entirely bury the wires. It was very necessary that the gutta-percha be of good quality. He had known the old material to last for sixteen years, and at the end of that time to be as good as new. Wires buried in clay soil were especially good, but in gravel they deteriorated if not entirely protected.

Mr. BELL said that the effect of tarred tape on gutta-percha wires was to reduce their insulation over 20 per cent. He had tried paraffin wax instead of tar, but the substance was too brittle. Ozokerit gave better results, and improved the insulation. The tape was saturated with the hot material, and when cold was wound on the gutta-percha wire.

Professor AYRTON drew attention to the fact that the new lines of underground work in Germany were in many places bricked and cemented in, so as to obtain complete protection.

The PRESIDENT, in conclusion, amongst other general remarks, stated that some years ago he had had a number of defective gutta-percha wires placed in a trough in a tunnel, and filled with a mixture of tar and pitch; these wires had lasted for fifteen years without failure, being quite perfect at the end of that time.

Mr. KEMPE then gave a description of his "Speed Indicator," an account of which will be found on page 175 of the present number of this Journal.

A paper by Mr. J. WILLMOT was then read, on "A New Form of Wheatstone Automatic Receiver." This instrument, which is specially adapted for high speed working, is driven by a weight, and is so arranged that the principal part of the mechanism can be detached with great ease from the driving weight without interfering with the latter. The axle of the wheel carrying the driving weight is connected with the axle of the principal wheel of the clockwork mechanism, by a bayonet joint, which prevents the separation of the two except in a certain position. When it is required to detach the two, a pawl is allowed to drop into the teeth of a wheel on the weight axle, which locks the latter, so that if the two axles are separated the weight cannot fall. When the separation is effected it is impossible to release the pawl, owing to the teeth of the wheel being undercut; the withdrawal can only be effected by the wheel being turned back by a handle.

The release of the two axles from the bayonet joint coupling takes place when a tooth of the ratchet wheel has come up to the hook of the pawl and becomes hitched; the momentum of the clockwork axle for the running of the wheels of the latter twists the bayonet joint to the position in which the two parts can be separated. The device is very useful, as it enables repairs to the parts of the mechanism liable to injury to be easily effected, it not being necessary to send to the workshops the rougher and heavier parts of the apparatus.

The speed at which the new form of instrument can be run at is 200 words a minute. The instrument, which was a model of constructive finish, was manufactured by Mr. Stroh.

It having been announced that Dr. Siemens' paper on "The use of the Dynamo-Electric Machine in Horticulture and in Metallurgy," which had been postponed on account of the indisposition of the author, would be read on a special night, and that the next paper read would be by Mr. Edward Graves, on "The Progress of Telegraphy," the meeting adjourned.

New Patents—1880.

1720. "Improvements in, and appertaining to, the attachment of telegraph and other electric conducting wires to insulators." J. R. EDWARDS. Dated April 27.

1738. "Permanent and electro-magnets, and electric telephones, and telephone circuits." W. R. LAKE. Dated May 4.

1751. "Electric signal apparatus for railroads." W. MORGAN-BROWN. (Complete.) Dated April 29.

1764. "Telephones." R. and M. THEILER. Dated April 30.

1820. "An improved apparatus for preventing collisions on railways." H. J. ALLISON. (Communicated by H. Bagilet.) Dated May 4.

1824. "Electric telegraphs." R. C. ANDERSON. Dated May 4.

1826. "Electric lighting." J. E. H. GORDON. Dated May 4.

1828. "Improvements in clocks, or time-keepers, and in apparatus for operating and controlling a series of the same by the aid of pneumatic pressure and electricity." W. R. LAKE. (A communication by the Compagnie Générale des Horologes Pneumatiques.) Dated May 4.

1840. "Apparatus for the production of electric light." W. R. LAKE. (Communicated by S. L. Clingman.) Dated May 5.

1907. "Railway signal apparatus." W. R. SYKES. Dated May 10.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

3659. "Apparatus and fuzes for electrical firing." SAMUEL JOSEPH MACKIE. Dated Sept. 13. 6d. Consists in using a leading wire to each electrical fuze in a series, and making a break in either the leading or return wire, and bridging the same by means of a movable contact maker.

3679. "Insulators." G. F. REDFERN. (A communication from J. H. Bloomfield, of Concordia, Entre Rios.) Dated Sept. 13. 6d. Consists of insulators

designed to be made of glass, porcelain, or glazed brown ware, with a convexed upper end, a concaved lower end, and two downwardly projecting cup-flanges around its upper part, covering the part around which the wire is to be fastened.

3697. "Electric lamps, or regulators." ALEXANDER M. CLARK. (A communication from J. M. Anatole Gérard Lescuyer.) Dated Sept. 15. 1s. Describes electric lamps, similar in principle to those of Mr. Hickley, described in TELEGRAPHIC JOURNAL, No. 163, and those of Mr. Wilde and Mr. John Rapieff, in No. 144.

3728. "Electric railway signals." THEODORE AL BURTIS PUTNAM. Dated Sept. 17. 4d. Consists generally in a system and appliances whereby a moving locomotive or train of cars at different times forms automatically a part of several electric circuits, by closing the same to operate an alarm placed on such locomotive or train. (*Provisional only.*)

3750. "Electric lamps." H. J. HADDAN. (A communication from C. F. Brush.) Dated Sept. 18. 8d. Consists of a double form of Brush lamp (see TELEGRAPHIC JOURNAL, p. 21, vol. vii.), and various modifications of same, and also of an automatic shunt or cut off.

3771. "Electric lamps." JAMES BROCKIE. Dated Sept. 19. 6d. This describes the Brockie lamp, illustrated on page 114, vol. viii., with some variations.

3777. "Electric pens." THEOPHILUS COAD. Dated Sept. 19. 2d. Consists in the application of a crane, suitably fixed with a pillar and arm, preferably formed hollow, for suspending and balancing the pen, so as to obviate the difficulty of maintaining puncturing pens in a perpendicular position, owing to the top weight of the apparatus. (*Provisional only.*)

3793. "Apparatus and application thereof for producing and subdividing the electric light." JOHN HARROP. Dated Sept. 20. 2d. Relates to improvements in the method of conducting the electric currents to and from the carbon points, used as the media for producing the electric light. (*Provisional only.*)

3794. "Apparatus employed in connection with telephones." ARNOLD WHITE. (A communication from Thomas Alva Edison.) Dated Sept. 20. 6d. Relates to improvements in the methods by which two separate electric circuits may be quickly united to form one, and as quickly divided so as to again constitute two distinct circuits. And further to electric annunciators, and also to an electric connecting board in combination therewith for telephonic exchange purposes.

3831. "Protecting and insulating underground telegraph wires." P. JENSEN. (A communication from W. E. Prall and Harry Obrick.) Consists of a metallic projecting pipe provided with an interior insulating tube or casing, which is made in sections so as to be easily introduced into the metallic pipe as it is laid, and which is made of asbestos, glass, fibre, slagwood, or other substance in combination with glue or other suitable cohesive substances. (*Provisional only.*)

3858. "Galvanic batteries." JOHN IMRAY. (A communication from Adèle Engström.) Dated Sept. 25. 4d. Relates to a construction of galvanic battery cell or element suitable for production of a constant current, the tension of which may be varied when desired.

3875. "Electric lighting." C. W. HARRISON. Dated Sept. 25. 6d. Relates to the manufacture of carbons made of lamp-black, wood pulp, or starch mixed with napthaline, pitch, or resin dissolved in boiling tar and maintained at a temperature of 250° F. The negative electrodes are also immersed in a neutral solution of iron, and thus are formed, when they are baked at a white heat, carbide of iron electrodes or conductors. Also a new current regulator is described.

City Notes.

Old Broad Street, May 12th, 1880.

GREAT NORTHERN TELEGRAPH COMPANY OF COPENHAGEN.—At the annual general meeting, held at Copenhagen, on the 24th April, 1880, F. Zahle, Esq., presided. The chairman, C. F. Tietgen, Esq., in reporting upon the Company's business generally, was glad to be able to say that the result of the past year's working had been very good, in fact, it had been the most favourable ever attained since the existence of the Company, and this, notwithstanding difficulties which the directors had had to contend with. The difficulties referred to above, mainly consisted in the interruptions of the cables. In the far east the cables had not suffered so much in this respect as in former years, and as the Company had their own repairing steamer in those waters, the repairs had been effected very speedily, in fact, the average of the interruptions had only been four days. In Europe, on the contrary, the cables had been damaged more frequently than in former years. The cause of these interruptions had been the same as usual, viz., breakages caused by ships' anchors and by trawlers. Hitherto the Company had, in order to restore these cables been obliged to rely upon the use of ordinary steamers, temporarily fitted up for the purpose, but as this was not only very costly, but gave rise to much loss of time, the directors had decided that the Company should acquire a ship of their own, specially built and supplied with all the latest improvements for this purpose. This cable steamer had been ordered of the Burmeister and Wain Company, at Copenhagen, the builders of the Company's repairing ship in the far east, the "H. C. Örsted," which had given satisfaction in every respect. The new ship would be somewhat larger than the latter and would be completed by the end of June next. The cost of the ship with full equipment, cable machinery, instruments, &c., would be about £22,000. Instead of investing the whole sum appropriated for the reserve fund, the above amount had been retained in cash in order to pay for the ship. Once in possession of that ship, the repairs would in future be effected at a considerably smaller cost than hitherto, and as a great saving in time would be gained an increase in the traffic receipts would naturally follow. Traffic.—In 1879, the receipts had, according to the traffic returns, been 5,195,168 francs compared with 5,087,816 francs in 1878, showing an increase of more than 100,000 francs. This increase was mainly attributable to the improvement in the traffic during the latter months of the past year, when a revival of trade first became apparent. During the early months of this year the same improvement has steadily manifested itself. It would be remembered that at the St. Petersburg Conference in 1875, the *word rate* was introduced for all extra-European traffic, and the results of the working of that system being satisfactory, it had been decided at the London Conference last year to extend it to the European traffic. There could be no doubt that by degrees the new rule would be appreciated by the general public, as messages containing as few as three words might now be transmitted at a very low charge, whereas formerly the lowest charge was made up for 20 words, however short the message might be. It was, after the short experience since the 1st April, impossible to say what the exact practical result would be for the Company, but considering that the very important traffic between Great Britain, Russia, and the Scandinavian countries, which passed over the Company's lines, related principally to mercantile and shipping interests, there were reasonable prospects of a further increase in the amount of the general traffic

passing over the Company's lines. Having regard to the present and the prospective augmentation of the traffic, and also to the fact that trawl fishing in the North Sea was fast increasing, in consequence of which the cables would be more liable to be damaged than formerly, it would be necessary to be prepared with the means to maintain an efficient service on all the Company's cable routes. The directors had therefore now under consideration the advisability of laying another cable from Great Britain to the Scandinavian countries. The question of how to carry out this intention in the most practical manner would to some extent depend upon the result of negotiations which would now be carried on with the different governments. The reserve fund would suffice for the expense incurred by this addition to the number of the Company's cables, but it would perhaps be more expedient not to absorb that fund, and instead thereof to obtain the required capital by the issue of 5 per cent. debentures, which might now easily be placed at par, and the interest of which would not form a heavy charge upon the Company's revenue. The directors would, however, when the proper time arrived, not fail to submit this question to the shareholders at an extraordinary general meeting. From the working account, it would be seen from the accounts that the gross receipts for the year 1879 had, including a balance of £14,837 11d., brought forward from 1878, amounted to £222,493 12s. 5d., whereas the total expenses had been £63,970 4d., leaving a net revenue balance of £158,523 12s. 1d.; out of this the interim dividend, at the rate of 5 per cent. per annum, already paid, absorbed £75,000. It was now proposed to deal with the remaining £83,523 12s. 1d. as follows:—To reserve and renewal fund, £44,444 8s. 10d.; to contribution to the pension fund of the staff, £503 9s. 3d.; to renumeration to the directors, £1,500; to extra dividend on 150,000 shares at the same rate as last year (2/9), £20,833 6s. 8d.; to balance to be carried forward to next account, £16,242 7s. 4d. Out of the amount referred to above, Kr. 350,000 4 per cent. Royal Danish Bonds, equal to £18,375, has been invested. The remainder has been retained in cash to meet the expense of the new repairing ship. The accounts were then passed, and discharge given to the directors.

FROM the Great Northern Telegraph Company we learn that the Japanese Telegraph Administration announces that henceforth a charge of ten dollars per annum will be made for all abbreviated addresses of receivers of messages registered in Japan. The addresses now registered will remain in force until the 1st September, this year, when they will be cancelled, if the above fee of ten dollars is not paid. The same administration announces that from the 1st July next their terminal rate for Nagasaki messages will be the same as for all other stations in Japan. The rate for messages transmitted by this Company's lines from this country to Nagasaki (hitherto 8s. 4d. per word) will therefore from that date be 9s. 3d., the same as to all other stations in Japan.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (Limited).—At the thirteenth half-yearly general meeting of the proprietors of this Company, held on May 7th, at the City Terminus Hotel, under the presidency of Lord Monck, the Chairman, in moving the adoption of the report, said that the first point to which he wished to draw attention was the amount of receipts for the half-year ending 31st December, 1879. They amounted in the gross to £77,504, which, compared with the previous half-year, showed an increase of £2,421, but it was not fair to compare one half with that which preceded it, as one half was more productive than the other. The present, however, as compared with the corresponding period of last year, showed an increase of £12,408. From the summary of traffic receipts they would observe that there had been a gradual but small progressive increase from the beginning of about £3,000 or £4,000 a year. The increase in this half-year was of a more substantial character. The increase was still going on, and he expected that the result of the current half-year would be better than any half-year they had had. This was in itself a subject of congratulation. Sir J. Anderson seconded the motion. A Shareholder urged that the dividend might be increased by 1 per cent. and still leave a good sum to be carried to reserve. Mr. Marshall concurred. Several other shareholders also urged that a smaller amount should be carried to reserve, in order that the dividend might be increased. Mr. Warren spoke in favour of continuing to build up the reserve until the increased dividend could be safely declared. The Chairman said that if the board, consistently with their duty, could pay a larger dividend next half-year they would do so. The report was then adopted, and a vote of thanks to the Chairman closed the proceedings.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The sixth ordinary general meeting of the West India and Panama Telegraph Company (Limited), was held May 12th, at the Cannon-street Hotel. Mr. C. W. Earle, chairman of the board of directors presided. The accounts for the six months ending 31st Dec., 1879, showed the amount to credit of revenue to be £35,630 7s. 1d., and the expenses have been £22,474 19s. 7d., leaving a balance of £13,155 7s. 6d., which, with the balance of £1,631 16s., brought from last half-year's account, makes a total of £14,787 3s. 6d. Of this sum the directors have carried £2,000 to reserve, leaving £12,787 3s. 6d. available, which it is proposed to deal with as follows, viz.:—First preference shares, half-year's dividend to 31st Dec., 1879, at 6 per cent. per annum, £10,368 18s. Second preference shares, half-year's dividend to 31st December, 1879, at 6 per cent per annum, £1,400 14s. Balance carried to current half-year's account, £1,017 11s. 6d. Total—£12,787 3s. 6d. In consequence of interruption of the Company's cables, the receipts for messages for the past six months are £493 less than those for the corresponding period of 1878. The Company's representations to the Demerara Government as to the non-payment of that colony's subsidy are still under consideration. It is understood that the matter cannot be definitely decided until the combined court meets in June next; under these circumstances the directors have not taken any part of this subsidy into account for the half-year. Several of the Company's cables are at present interrupted, whereby telegraphic communication is cut off beyond Porto Rico. Special boats have been engaged to carry the traffic over the broken sections. The directors have terminated the charter party of the s.s. *Caroline*, temporarily employed as repairing ship in the West Indies, in consequence of extensive repairs required to her boilers. The Company's new repairing ship, the s.s. *Grappler*, arrived in the Thames on the 11th March, and was as speedily as possible fitted with the necessary cable machinery, loaded with 268 knots of cable, and sailed from Gravesend on the 8th April. She may be expected to arrive at St. Thomas about the end of April, and will immediately proceed to repair the interrupted sections. The general reserve account, stated in the balance sheet at £30,489 18s. 4d., had been at 31st December, partly applied to the purchase of cable in stock, and since that date £9,217 8s. of the investments in respect of reserve fund have been realised, and the proceeds applied towards payment for the new ship. In moving the adoption of the report, which was taken as read, the Chairman remarked that although the receipts showed a falling off of £500, in comparison

with the corresponding period in the previous year, there was really a balance to the credit of revenue of about the same sum. This was to be accounted for by the fact that they had received £500 more subsidy from Jamaica, and that they had had to expend less on cable repairs. Of course the latter was only a matter of luck. The general reserve account at the time of the drawing up of the report stood at £30,489. This had been applied partly to the purchase of cable in stock, and £9,217 of the investments in respect of the reserve fund had been realised, and the proceeds applied towards payment for the new ship. They had had a telegram announcing the arrival of their new steamship. She was now on her way to repair some of the interruptions they had had. By hitting upon a fortunate time for the making of the contract for that vessel they had saved a large sum of money. In consequence of the low price of materials the contract price was £14,500, whereas at another time it would be as much as £20,000. The whole cost of that vessel would stand at about £17,000. A very satisfactory judgment had been given by Lord Justice Baggallay as to the claim of £15,000 insurance of the *Investigator*, but no settlement had as yet been obtained. On the contrary, the underwriters had carried the case to the Court of Appeal. As for the general position of the Company, the refusal of the Government to grant a subsidy to them was not, under the circumstances, a very great surprise to him. Besides, no great public attention had been of late called to the West Indies. He was afraid that it required something like an Isandula affair to establish the importance of telegraphic communication, but he thought the Government ought not to forget what had occurred in Jamaica and Barbadoes before these telegraphic cables were laid, and all that might have been obviated in past times had the telegraph been in existence. These matters ought to have some effect on the public mind as to the importance of giving support to such a Company as this. It was at all events satisfactory to find that the refusal of the Government to grant a subsidy had altered the tone of the colonial press towards the Company. The directors were at present considering as to what might be the best time to bring the matter before the Colonial Government, who it was hoped would look upon the matter in a business-like way, and one favourable to the Company. As to the question of the non-payment of the subsidy from Demerara, the point in dispute had to do with what was known as the "Grace Clause." The Attorney-General of Demerara had advised that the Grace Clause once taken advantage of cannot be again exercised. The Attorney-General of England had given an opinion opposed to this. The latter opinion had been placed before the Demerara Government, and it was understood that when the combined courts met in June the whole matter would be discussed. Mr. W. Ford moved the motion for the adoption of the report. The Chairman, in reply to questions, said that unless the Company was aided by larger subsidies the directors would not be inclined to advise the investment of any more capital in the undertaking. The report and the recommended dividend of six per cent. per annum were approved, and the retiring directors were re-elected. A vote of thanks to the chairman and directors concluded the business.

THE GERMAN UNION TELEGRAPH AND TRUST COMPANY, LIMITED.—The report of the directors for the year ending 1st May, 1880, states that the total receipts during the year amount to £12,227 17s. 6d., which, with a balance of £40 4s. 5d. carried forward from last account, make a total of £12,268 1s. 11d. The working expenses for the same period amount to £4621 3s. 3d., leaving a balance of £11,805 8s. 8d. Out of this amount an interim dividend of 5s. 9d. per share was distributed on the 21st January last, and the directors now beg to recommend the payment of a further dividend of 6s. per share, making a total distribution for the year of 11s. 9d. per share, free of income tax, or at the rate of £5 17s. 6d. per annum upon the capital of the Company, and the directors have also written off £74 17s. 3d. from the expenses of formation of the Company, leaving a balance of £51 1s. 5d. to be carried over to the next account. The Company's cable and land lines remain in good order and condition, and business during the last year has been going on in a satisfactory manner. The Telegraph Conference, held last year in London, has led to the introduction of some important changes, such as the general introduction of the one word rate, and the reduction of tariffs, which so far have led to a diminution of revenue. According to the articles of association, H. G. Erichsen, Esq., one of the directors of the Company, retires by rotation, but, being eligible, offers himself for re-election. The auditor, Mr. Henry Dever, also retires, but offers himself for re-election.

THE cable between Hong Kong and the Island of Luzon, by which Manilla is brought into direct telegraphic communication with other telegraph systems, is now complete, and open for traffic. The rate from any place in the United Kingdom is 10s. per word, either by the Eastern Extension or the Indo-European Telegraph Company.

ACCORDING to the report just issued, the net profits of Reuter's Telegram Company (Limited) during the past year, including £113 brought down, were £7,101, out of which the usual interim dividend of 2½ per cent. has been paid. The directors now declare a further dividend of 5 per cent., making 7½ per cent. for the twelve months, and leaving, after the addition of £1,500 to reserve, £108 to be carried forward.

The following are the final quotations of telegraphs:—Anglo-American Limited, 62¾-63¼; Do., Preferred, 92-93; Ditto, Deferred, 35½-36; Black Sea, Limited, ——; Brazilian Submarine, Limited, 7⅞-8⅛; Cuba, Limited, 9½-10½; Cuba, Limited, 10 per cent. Preference, 16¼-16¾; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 10½-11½; Direct United States Cable, Limited, 1877, 11¾-12¼; Scrip of Debentures, 100-102; Do., £50 paid, par-2 pm.; Eastern, Limited, 8¾-9; Eastern 6 per cent. Preference, 12¼-12¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 101-104; Eastern 5 per cent. Debentures, repayable August, 1887, 101-103; Eastern, 5 per cent., repayable Aug., 1899, 102-104; Eastern Extension, Australasian and China, Limited, 9-9¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 107-110; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 102-104; Ditto, registered, repayable 1900, 102-105; German Union Telegraph and Trust, 8¾-9¼; Globe Telegraph and Trust, Limited, 6-6¼; Globe, 6 per cent. Preference, 11⅛-11⅝; Great Northern, 9¾-10; Indo-European, Limited, 24-25; London Platino-Brazilian, Limited, 5¼-5¾; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 10½-11½; Reuter's Limited, 10-11; Submarine, 230-240; Submarine Scrip, 2¼-2¾; West Coast of America, Limited, 2-2¼; West India and Panama, Limited, 1¾-2; Ditto, 6 per cent. First Preference, 8-8½; Ditto, ditto, Second Preference, 7-7½; Western and Brazilian, Limited, 7⅞-8; Ditto, 6 per cent. Debentures "A," 100-103, Ditto, ditto, ditto, "B," 100-103; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 117-122; Ditto, 6 per cent. Sterling Bonds, 103-105; Telegraph Construction and Maintenance, Limited, 34-34½; Ditto, 6 per cent. Bonds, 104-108; Ditto, Second Bonus Trust Certificates, 3¼-3¾; India Rubber Co., 14½-15; Ditto, 6 per cent. Debenture, 104-106.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 176.

POST OFFICE TELEGRAPHS.

AN interesting paper was read at the last general meeting of the Society of Telegraph Engineers by Mr. E. Graves, Engineer-in-Chief of the British Postal Telegraph Service. The title of the paper was, "A Decade in the History of English Telegraphy." Coming from a person so competent to make a clear statement of the subject with which he dealt, as the Engineer-in-Chief of the Postal Service, the paper is especially valuable as a defence of the work which has been done and the progress made since the transfer of the telegraph systems of the United Kingdom into the hands of the State. The statements which have been made by various public journals, whether scientific or otherwise, on the subject of the Postal Telegraph system, have been in almost every case the reverse of flattering; in fact, it has been plainly stated that the Service in question is an example of how not to do the work, and that practically no progress has been made, and telegraphic invention has been stifled. Part of this misunderstanding has arisen from estimates drawn up upon a false basis. With regard to the non-encouragement of telegraphic invention, the outcry has been raised mostly by disappointed inventors, who are firmly persuaded that they know far better than those who have had years of experience what the actual requirements of the Service are.

With regard to the actual increase of facilities for transmitting telegrams, the fact is unquestionable that, whereas in 1869 there were but 2,488 offices open, there were in 1879, 5,331 offices, and, as Mr. Graves pointed out, this increase does not represent the actual increase in convenience, since in 1869 there were three and sometimes four competing companies in one town, each of whom had their office, so that in making a comparison, these offices should be only reckoned as one; in other words, the effective number of offices in 1869 could only fairly be reckoned as under 2,000. A similar source of inaccuracy, which has not been observed, consists in the fact, that in estimates of messages transmitted in 1869, a single message has been reckoned as two or three, since each company over whose lines the message passed *en route* to its final destination has the message in question recorded in their totals. If due allowance is made for this fact, the total number of messages transmitted in 1869 cannot be taken to exceed 6,500,000, whereas in 1879 the actual number was 25,547,137.

Complaints of delays have been frequent, and no doubt in isolated cases have been justified, but when we know that the number of fast speed instruments in 1869 was only *four*, whereas in 1879 it was *one hundred and seventy-three*, it can hardly be said that a very great deal has not been done towards getting the work off quickly. With regard to the question of the stifling of invention, Mr. Graves puts the matter very plainly. He says:—"When an alteration would have the effect of throwing out of use a large stock of apparatus in which a very large capital had been embarked, it is clear that such an alteration must be of a very decided advantage to justify the commercial waste, so to speak, that must arise from its adoption. . . . But wherever good has been found, it has been availed of. The inventive genius of our Transatlantic cousins has had a fair field of action in our borders, and its worth has been fully and practically acknowledged."

That we have not found it necessary to go outside the Department for inprovement, is instanced by the examples given of the work now executed by the Wheatstone fast speed instruments, which is of a very remarkable character; this is only a solitary example, but improvements of a steady though not showy character are constantly being made by the engineering staff, improvements which are not heard of, but which are none the less real, as would soon be seen and acknowledged, if it were possible for outsiders to have an intimate knowledge of the internal economy of the Department.

We do not mean to say that the Postal Telegraph Department is perfect; several improvements are no doubt requisite, and must be made in due time. The 6d. rate cannot long be deferred, and an extension of the hours during which the offices are kept open is desirable and must eventually be made. But in spite of the defects, we quite agree with Mr. Graves that the British Postal Telegraph Service is unequalled in the world for efficiency.

THE GALVANOMETER OF MARCEL DEPREZ.

THIS instrument will cause considerable surprise to all physicists who see it for the first time, and will excite wonder that it was not invented before. It is, in fact, a correct and simple carrying out of a principle which is obvious when seen.

M. Marcel Deprez has invented and constructed a galvanometer suitable for measuring powerful

currents, and for measuring them quickly and directly.

All readers of this journal are aware that powerful currents can be produced, not only by powerful sources, but also by sources relatively feeble, so long as the resistance of the circuit be small. They can see, then, that the instrument once invented could be used for various purposes. This being granted, M. Deprez considered that he could reduce to a minimum the mass of the movable needle and submit it to very powerful actions.

He placed between the horns of a powerful magnet a little needle of soft iron mounted upon an axis passing through its middle. The wire conducting the current, which it is required to measure, is placed between the horns of the magnet and around the soft iron needle; the turns of wire being few in number, their resistance was very small.

An indicating needle of aluminium, or, better still, of straw, acted as an index hand, and completed the instrument.

The axis of the needle lies in the general plane of the magnetic meridian.

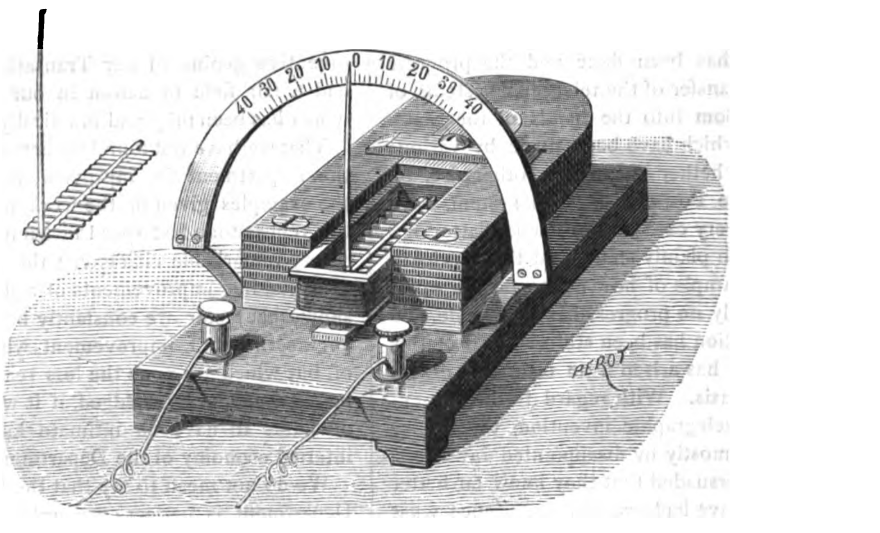
The needle of soft iron is compound, being composed of from 12 to 18 parallel needles.

The index needle is set at right angles to the magnetic needle, so that its indications can easily be seen on the dial of the apparatus.

Instead of the needles placed side by side in the same plane, a plate of iron formed of several layers touching one another can be used; this second arrangement possesses certain advantages.

A third form has its axis in a direction perpendicular to the plane of the magnet. The index needle in this case is parallel to the plane of the magnet, the dial is set over the magnet, and the apparatus is reduced almost to the size of the magnet.

Other arrangements have also been designed, and can be designed, which will answer various requirements, and upon which it is not necessary to insist.



The directive action of the magnet is considerable, hence it is evident that the deviations with powerful currents can be small; but experiment shows this in a striking manner. When the needle is moved from its position of equilibrium it returns sharply to its normal position, oscillating once or twice with great rapidity.

The action of the current is to cause the needle to spring to its new position. Under these circumstances the oscillations of the needle are still more rapidly brought to rest; they have, in fact, the character of tuning-fork vibrations.

The rapidity of the indications is still greater when the variations of the current strength are less marked. It follows from this that the smallest and the most transient variations of the current are rendered visible by this instrument, whilst the instrument is not affected by external forces.

The apparatus naturally can be made in a variety of forms; the one represented by the figure has been chosen as being the best.

We will now consider the properties of this instrument. It is evident that the needle cannot be demagnetised, since it possesses no inherent magnetism. Neither is it necessary for the instrument to be set east and west, since the needle, being placed in a powerful magnetic field, is not affected by the terrestrial magnetism. In fact, the instrument can be placed indifferently in any position whatever.

But what is of the greatest importance is, the faculty which the instrument possesses of giving instantaneously the actual measurement of the current, and the accuracy of its indications; this is amply proved by experiments made by various persons who have used the instrument.

If the galvanometer is placed in the circuit of a Gramme machine, all the variations of the velocity of the latter can be seen with the greatest clearness. One can even see the slight movements which show the current not to be a constant one, but to have the character of a wave, a proof which hitherto the

telephone had been the only instrument capable of showing.

We will conclude by expressing our belief that the new instrument of Marcel Deprez is destined to be of great service to the physicist in the laboratory, and to the engineer who has charge of dynamo-electric machines in their numerous applications.

A. NIAUDET.

SIMPLE TELEPHONE TRANSMITTER.

By GEO. M. HOPKINS.

THERE are telephones and telephones, but in the host of instruments so named the successful ones may be counted upon the fingers of one hand. Of telephonic receivers it may as well be said there are but two, for there are only two principles involved in their construction. Of transmitters there are but two that have gained any notoriety and retained their foothold as useful instruments.

Having a chronic liking for telephonic research, I have made it a point to try the various telephones as they have been made known to the public, and have found that with but few exceptions they are defective and useless as practical instruments, and interesting only at exceptional times when the conditions for experiment are favourable, and the adjustments delicately made.

In the course of these experiments the transmitter shown in the annexed engraving was devised, and it was subsequently developed into a usable instrument possessing all of the qualities requisite in a telephone. In the first place, it is so simple as to be capable of construction by the merest tyro, and never needs adjustment. It requires neither call bell, keys, nor switches when used in an ordinarily quiet place, with a closed local circuit.

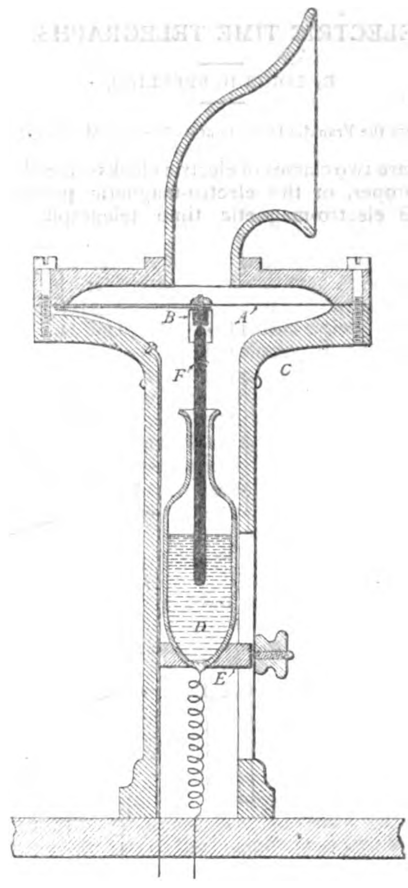
The transmitter is fixed to a bracket and stands vertically, with its sound-collecting mouthpiece pointed in the direction whence the sound proceeds. The receiver, which is an ordinary Bell instrument, stands, when not in use, over a curved pendent resonator, the smaller end of which projects through the shelf of the bracket and just enters the hole in the centre of the receiver mouthpiece.

Between the transmitter and the receiver there is a small induction coil, whose primary wire is connected with the local battery and the transmitter. One terminal of the secondary wire of the coil is connected with the receiving instrument and line, the other terminal is grounded.

The construction of the transmitter will be seen from the figure. The diaphragm, A, has attached to its centre a small brass cup, B, containing a button of ordinary battery carbon three-sixteenths of an inch in diameter, and about the same thickness. This carbon projects beyond the brass cup, and is surrounded by a short paper tube, which projects beyond the face of the carbon one-eighth inch. A piece of copper foil placed between the brass cup, B, and the diaphragm extends to the edge of the diaphragm, where it is pressed by a spring in the cell, C, which is in metallic contact with a wire extending downward through the lower end of the instrument.

The standard supporting the diaphragm cell is hollow, about five-eighths inch internal diameter, and the height of the diaphragm above the bracket is four inches.

In the standard there is a bottle, D, of special form, supported by a ring, E, having a threaded stud extending through a slot in the standard, and provided with a milled thumb nut, by which it may be clamped at any desired height. The bottle, D, has a long narrow neck, about three sixteenths inch internal diameter, and a platinum wire blown in the lower end connects with the local circuit wire, which is coiled to admit of moving the bottle up or down. This wire extends through the base of the instrument, and is connected as shown in figure. The



bottle, D, is partly filled with mercury, in which floats a pencil, F, of carbon of the kind used for electric lighting by incandescence. This pencil is one-eighth inch in diameter, two and one-eighth inches long, and is made slightly convex and very smooth at the ends. The mercury buoys the carbon up so that it is always kept in light and uniform contact with the carbon button, while it also forms part of the conductor in the local circuit. The carbon attached to the diaphragm is perfectly plane on its contact surface, and as smooth as it can be made by means of a fine file.

The diaphragm, which is of mica, has one and three-fourths inches free to vibrate. It is rather stiff, and is clamped firmly in its cell. The surfaces between which the diaphragm is clamped are perfectly true, and made of material not liable to warp. Wood well soaked in paraffine answers a good purpose, but vulcanite is far better.

The induction coil used with the instrument is of the ordinary form, two inches long, one inch in diameter, with a three-eighths inch core of No. 18 soft iron wires. The primary coil consists of three layers of No. 18 silk-covered copper wire, and the secondary of No. 36 in sufficient quantity to fill the spool. One cell of Leclanché or Fuller battery will work the transmitter, but two will augment the volume of sound.

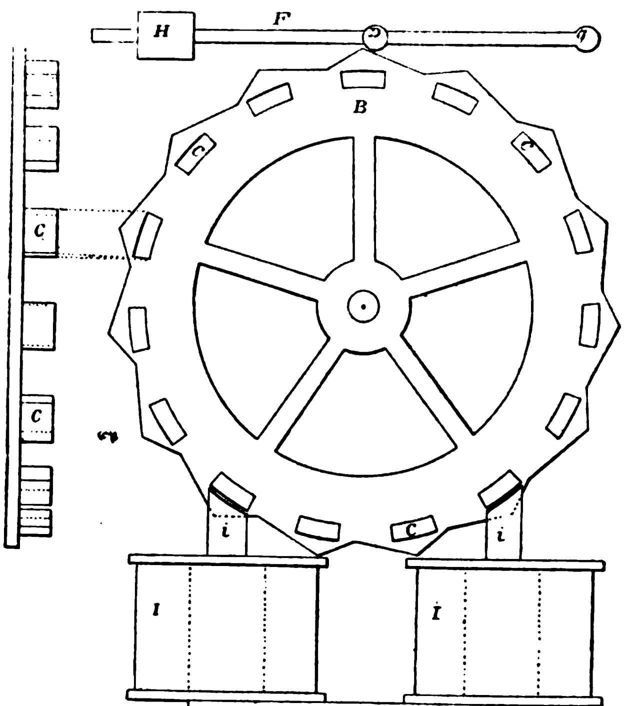
As to the efficiency of this instrument, it will bear comparison with other transmitters, and in one or two points it seems to have an advantage. It will transmit speech clearly whether the speaker is within ten inches or as many feet of the instrument. Although a call bell may be used in connection with it, generally none will be required, as by saying o-o-o-o loudly in the mouthpiece a trumpet-like sound is heard in the receiver at the other end of the line, which, although not very loud, is sufficient to attract attention in a measurably quiet room.—*Scientific American.*

ELECTRIC TIME TELEGRAPHS.

By LOUIS H. SPELLIER.

Read before the Franklin Institute at its Meeting March 17th, 1880.

THERE are two classes of electric clocks—the electric clock proper, or the electro-magnetic pendulum, and the electro-magnetic time telegraph. The



former has been to this day more of a scientific curiosity than a useful invention. It is only the latter, the electric time telegraph, which has proved a partial success. As the name indicates, they are instruments which receive the time telegraphed. For this purpose a standard clock, which in certain intervals of time completes or breaks the circuit of a galvanic battery, is needed. Although many and various in construction, they all resemble each other very closely in their most essential parts.

They mainly depend upon the action of one electro-magnet and one armature. The latter is a piece of iron, which is attracted by the poles of the electro-magnet when the telegraphing clock completes the circuit of a galvanic battery connected with it. As soon as the clock breaks the circuit again the armature is repelled to its former position by a spring or weight. This movement of the armature turns a wheel which drives time-indicating machinery, and is repeated as often as this machinery requires to indicate the time of the clock, which makes or breaks the electric circuit.

Such instruments work very well if the action of the armature is needed about once every minute, but if repeated every second or two, then its im-

perfections become apparent. The movement of the armature is sudden and rapid. With a lightning-like velocity the armature moves toward the magnet, and is checked instantaneously in its rapid progress just at a time when nearest the magnet and most powerfully attracted. Naturally the wheel, which receives its moving impulse directly from the armature, moves with the same rapidity and is checked as suddenly. Those sudden checks, offered to the armature and wheel, show their damaging results in a comparatively short time, and soon impair the correctness of such instruments.

In correcting these destructive evils I never succeeded completely until an entirely new system suggested itself to me, and of which the accompanying figure shows the principle.

Instead of one armature I have a number of them, C, fastened at equal distances around the circumference of wheel B. With B on the same axle another wheel is fastened, having as many cogs, of the peculiar shape shown in the figure, as B has armatures. F is a lever with its oscillating centre at *g*, and has a pulley, D, which presses against the circumference of the wheel, B, by the weight, H. I *i* is the electro-magnet. The electro-magnet is connected with a galvanic battery, of which the circuit is closed and opened by the oscillations of a pendulum. The instrument acts in the following manner :—

When the current of the galvanic battery is closed, the armature, C, will be attracted by the electro-magnet, and move A and B in the direction indicated by the arrow, and stops as soon as C is directly over it. When in this position the pulley, D, rests upon the upper part of the cog, and presses against it. As soon as the electric current is disconnected, and the electro-magnet discharged of its magnetism, the pressure of the pulley, D, against the cog moves B in the direction indicated by the arrow, and stops moving when the pulley has reached the deepest point of the cog. This movement of B has brought the next armature, C, near to the magnet, *i*. This armature will now be attracted at the next closing of the electric current. Then B will be moved again, and the cog will take the first position, and the pulley, D, presses upon it, ready to move the wheel as soon as the electro-magnet is again discharged of its magnetism ; and so on alternately, the electro-magnet and the pulley will interchange their action, and keep B revolving in the manner as the pendulum of the clock connects and disconnects the electric current.

The object in view, to avoid the sudden check to the armature, is hereby accomplished. No sudden check is offered to the armature, but when attracted it swings for a moment in short vibrations over the magnet before it comes to rest. It is comparatively noiseless in its movements, its sound being hardly perceptible. In this respect it is very much unlike other time telegraphs, whose clapping noise is their constant companion.

A time telegraph of this kind in operation at the monthly meeting of the Franklin Institute had, like the accompanying figure, fifteen armatures (the wheel on which they were mounted measuring five inches and one-half in diameter), and two electro-magnets. With six cells of a Daniell battery it proved to have ample power to drive four dial works for dials 5 feet 6 inches in diameter. It may have as many electro-magnets as it has armatures. This is a circumstance of some importance, since it will increase its driving capacity with each additional electro-magnet without adding materially to the size of the instrument.

Whatever the reason may be, there is no doubt that, to this day, the time telegraphs have not received such notice as they really deserve. Their service can be more useful and general than is mostly admitted. If we consider that we can control by one correct time-piece just as many time telegraphs to indicate true time as necessity or fancy requires, providing there is battery power enough to move them, we have reason to believe that they still may come into general use in hotels and public buildings, where true and equal time in every room of the house is desirable.

But there is still another field of great importance for the time telegraph. It has been a problem of great perplexity, to this day, with the most ingenious minds of the horological world, how to construct clocks which will overcome the effects of wind and storm beating against the exposed clock dials of public clocks. It is true, remontoires and gravity escapements have been invented to remedy the evil, and clocks may go better with them than without them ; but, nevertheless, all these ingenious contrivances have almost as many evils, on account of their complication, as they are designed to avoid. And here it is where the time telegraph has its future. A well-regulated clock, kept at a place of even temperature, will show but very little variation of time. If such a clock controls a time telegraph adapted for tower or public clocks, it will show the time with only such slight variation as will hardly be noticed by the public.

One objection raised against time telegraphs—the use of the galvanic battery—can be an objection no longer. Its treatment is now almost generally understood, since it has found its way into so many branches of business of every-day life. There is little room left to doubt that when the utility of the time telegraphs is once recognised it will receive more deserved notice and be brought into more general use ; and the time may not be far distant when the subtle power of electricity will regulate all our better class of tower or other public clocks.

Oil testing by Electricity.—A new method of testing oils has been devised by Mr. F. S. Pease, of Buffalo, New York. The oil is placed in a vessel placed in a water-bath which is supported in a closed heating chamber ; a small dome with a glass window at the top of the chamber has two insulated wires led into it whose ends are a short distance apart. When the oil is heated to a certain point the inflammable vapour is given off and this can be ignited by a spark between the two wires generated by an induction coil. In the ordinary system of testing, the light to ignite the vapour has been applied indiscriminately at any point above the level of the liquid, and unless this height is the same in all tests different results are obtained ; other sources of error also exist unless the conditions for making the test are similar. By Mr. Pease's device these effects are entirely got rid of and accurate and trustworthy results obtained.

JOHNSON AND PHILLIPS' PATENT MARK BUOY.

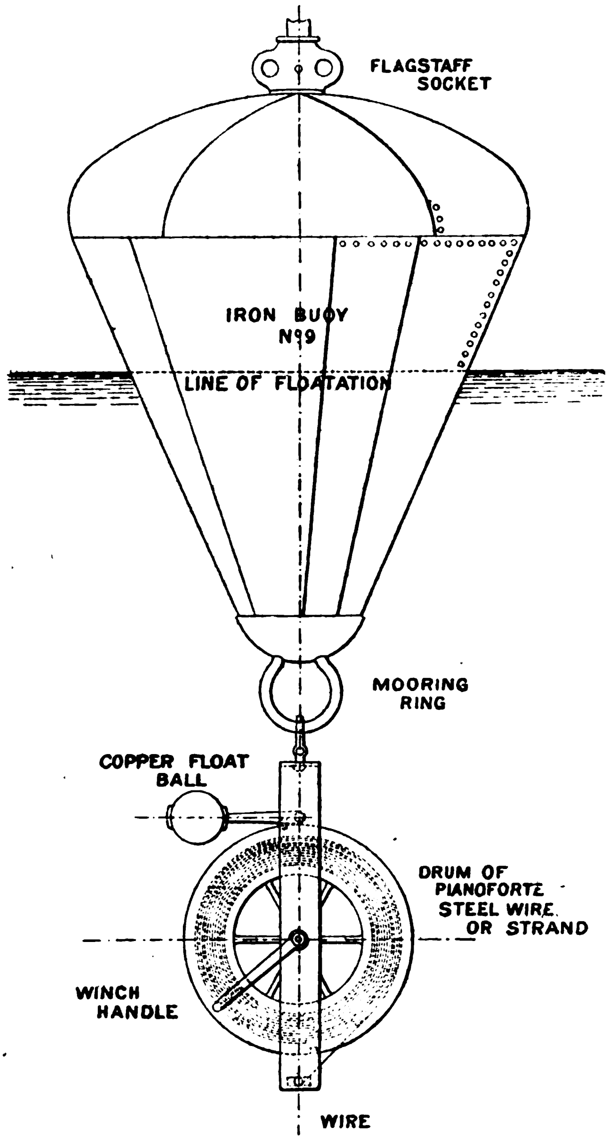
The object of this arrangement of moorings is that vessels employed in laying or repairing Submarine Telegraph Cables may be provided with a means of marking a "position" without the loss of time which usually attends this operation, and at a comparatively small cost.

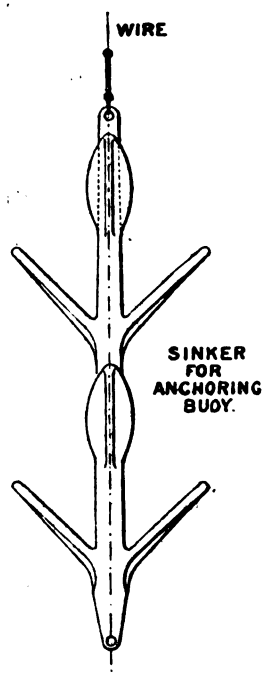
The buoy is suspended over the water by a line made fast at any convenient projection at the quarter or stern of the vessel, so that when this line is cut through, the buoy will drop into the water, clear of the ship's side.

These buoys are made in several sizes; a reference to the annexed drawing will show the arrangement of parts when in working position.

The action of the apparatus is as follows:—On letting go the buoy, the copper float ball, which operates a catch or detent, is lifted, and the drum containing the steel wire is free to revolve. The drum then pays out the whole of the wire, the length of which should be considerably in excess of depth of water. A winch handle is provided, so that the moorings may be recovered, but the cost of a sinker and mooring wire is so small, that, as a rule, it will not pay to recover it.

Several drums containing length of wire suitable for different depths of water are provided, and these are easily placed in the drum frames.





AN ELECTRO-MAGNETIC TELEPHONE RECEIVER.

In our issue of May 1st, 1879 (No. 150, vol. 7), we described Mr. Louis J. Crossley's modification of the Hughes microphone, which has already attained to a very high position as a telephone transmitter.

This must alike prove a source of satisfaction to Professor Hughes, who discovered the germ, and to Mr. Crossley, who developed it into the present efficient instrument.

In the article we have referred to, the apparatus was illustrated as working with an ordinary Bell telephone.

A thin iron armature, D, is cemented down on one side to the top of the wooden case, the other end being left free.

The instrument having been adjusted by means of the screw, P, is filled with paraffin wax to within half an inch of the top, in order to reduce the cavity inside the case and thus render the tone purer.

Another form of the receiver is shown by fig. 2. This instrument has a somewhat different adjusting spring to the first form, and has two electro-magnets in place of one.

The internal connections of the transmitter are so arranged that when the receiver is lifted off the switch, ready for speaking to, a current flows out

Fig. 1.

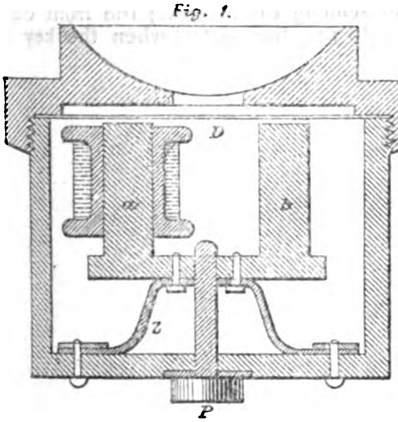
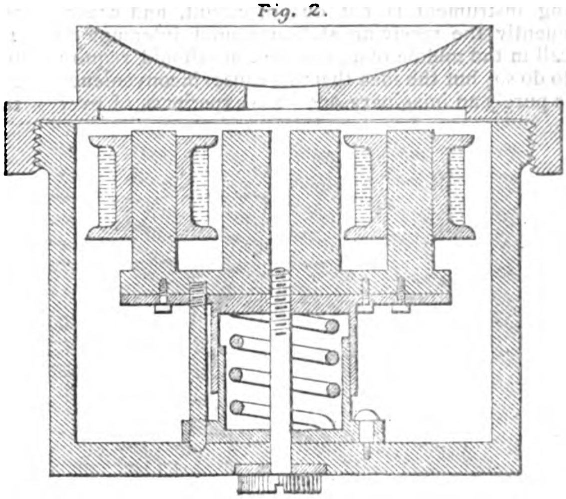


Fig. 2.



We have now the pleasure of describing an electro-magnetic telephone receiver, which is being used in conjunction with the Crossley transmitter with very satisfactory results.

One form of this instrument is illustrated in section by fig. 1. The electro-magnet, *a*, *b* (carrying one bobbin of wire), is firmly screwed to the steel spring, z, which is screwed down to the case of the instrument by means of two screws from the outside.

through the receiver to line, thus magnetising the receiver, which is, of course, essential to the proper working of the apparatus.

From this it will be gathered that the volume of the sound in the receiver depends largely on the strength of the current flowing in the line and receiver, and that by proper arrangement this may be so augmented as to become comparatively loud.

With lines up to 9 miles in length, 6 Leclanché cells are said to give very satisfactory results.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

X.

Double Current System—(*continued*).

Faults.

The faults to which the Double Current system is liable are chiefly due to defects in the key. If the pad under the front of the lever is screwed too high up, contact will not be made by the upper contact springs; a like fault will occur if the latter be bent up or broken. Dirty contacts seldom if ever occur, as the comparatively long play of the lever gives rubbing surfaces. The switch contacts may fail from the levers of the same being bent, or, again, the ebonite connecting bar may be broken; such faults ought, however, never to occur, as they can only be due to very rough handling.

It can easily be seen if the key works properly, by observing the galvanometer needle; the latter should move to the left when the switch is over to "send," and the key in its normal position, but should move to the right when the latter is depressed.

In order to determine whether an interruption is caused by a line or an instrument fault, terminal of the key should be connected by a piece of wire to the right-hand terminal of the galvanometer, the other connections remaining undisturbed; on turning the switch to "send" and working the key, signals ought to be produced on the receiving instru-

ment, which signals, however, will be reversed, that is to say, the key in its normal position will "mark," and, on being depressed, will "space." This will show that the receiving apparatus and the battery are in proper condition.

If, when the switch is at "receive," wires from the battery terminals, z and c, be touched to terminals 7 and , then the receiving instrument should respond.

The attempts which have been made to get rid of the "switch," which is provided with every double current key, have been very numerous and unsuccessful. These attempts have almost all been made by persons entirely unacquainted with the practical working of double current circuits. It is quite true that when the switch is over to "send," the receiving instrument is cut out of circuit, and consequently the receiving station cannot interrupt or call in the middle of a message if he should require to do so; but the idea that this causes inconvenience is purely an imaginary one—the experience of over 20 years has proved that no trouble arises from the supposed defect. Again, it has been argued that if the switch is not moved over from "send" to "receive" at the completion of a message, the circuit will practically be broken down, as the distant station cannot call. As a matter of fact, a fault arising from this cause is of very rare occurrence indeed; from constant habit, the movement of the switch, when working is commenced or ceased, becomes such a mechanical motion with the operator that it is done almost unconsciously. But even if it did happen that the switch was not moved over to "receive," the movements of the galvanometer needle, which, as will be seen from fig. 40, Article VIII., is in the line circuit, would at once indicate that the distant station is calling; these movements would be almost certain to be noticed, as in a busy office (where alone the double current system would be employed) clerks are always in attendance and looking out for a call.

But even if the abandonment of the hand switch were considered advisable, it is certain that it is not possible to cause it to act automatically by the back movement of the key, that is to say, to cause the key after it has sent the reversal to put the line through the receiving instrument. It must be remembered that the idea of getting rid of the hand switch is to enable the distant station to call "whilst a message is being sent," consequently no device for moving the switch automatically "on the completion of the message" would be of any use. The reasons for concluding that no arrangement for the purpose indicated can be designed, are as follows:—

To enable double current working to be thoroughly efficient, it is very necessary that the duration of the contacts be as long as possible; so well is this known to be the case, that spring contacts similar to those shown in the double current key, fig. 41 (Article VIII.), are always used and found to be necessary. The spring contact is particularly requisite for sending the reversal; the front contact, that is to say, the contact when the key is depressed, may, without inconvenience, be made "dead," as in the single current key, but the back contact must be a spring. The reason of this is to be found in the fact that there is a natural tendency in the operator to dwell longer upon the front contact than upon the back contact, and therefore there is a tendency to cut short the reversal current due to the former; but the actual duration of the reversal is, in practice, sufficiently long, because the contact remains on:—1st. For a portion of the time during which the key is rising. 2nd. For the whole time whilst the key is at rest on the back contact (which period is of lengthened duration); and 3rd. For a portion of the time during which the key is being depressed. Now the total duration due to all these three periods, and especially to the second, is by no means too long when quick working over long lines takes place, and to cut it short would be to seriously impair the signals, more especially when we consider that the marking and spacing currents will be of very unequal duration. To switch in the receiving

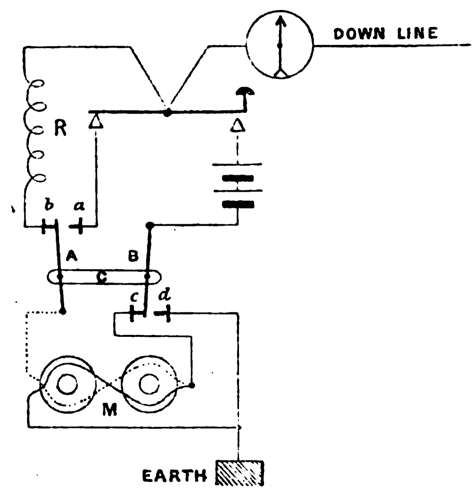


Fig. 48.

instrument for a portion of the time during which the reversal current ought to be flowing must obviously cut the latter short, and this is what must be done if an automatic switch is introduced; the impossibility of using the latter is, therefore, as obvious theoretically as it is found to be practically.

DIRECT WRITER DUPLEX SYSTEM.

In the ordinary Morse duplex system, as is well known, the lever of the transmitting key is connected to the two ends of the differential coils of the electro-magnet, the other end of one coil being connected to line, and the other end of the second coil being connected to the artificial resistance; then if the key is depressed so as to make contact with the battery, the current from the latter splits, half going through one coil of the electro-magnet and then through the line to the distant station, whilst the other half goes through the second coil of the electro-magnet, and then through the artificial resistance to earth. Now, it is evident that the same result will be obtained if the one half of the current goes first through the line and then through the one coil of the electro-magnet, whilst the other half goes first through the artificial resistance and then through the second coil of the electro-magnet. The latter arrangement is the one adopted in the Postal Direct Writer instruments for a special reason. The successful working of the duplex system of course depends upon an accurate balance being obtained; and in England, where climatic changes are very frequent, it is sometimes extremely difficult to preserve this balance, in such a case duplex working becomes practically out of the question, and ordinary single working must be resorted to. In order that the change in the connections, necessary to convert the one system into the other, may be made without loss of time, all the duplex direct writer instruments are now fitted with switches, by the turning of which the required change is at once made. Now this result can be effected in the simplest manner and with the fewest changes of connections, if the duplex arrangement is made in the manner which has been referred to, consequently it is the one now adopted.

Fig. 48 shows the theoretical arrangement of the connections. A, B, are two levers linked by the bar, C, so that they move together. In the position indicated in the figure, the apparatus is arranged for duplex working; the action may then be explained as follows:—On depressing the key the one half of the current flows out to line and back through the earth at the distant station to "Earth" at the sending station, and thence through the coil of the instrument, represented by the continuous line, to contact point, *c*, and from there through lever, B, back to the battery. The other half of the current flows through the balancing resistance, R, to contact point, *b*, and thence through lever, A, and the coil of the electro-magnet, represented by the dotted line, back to the battery.

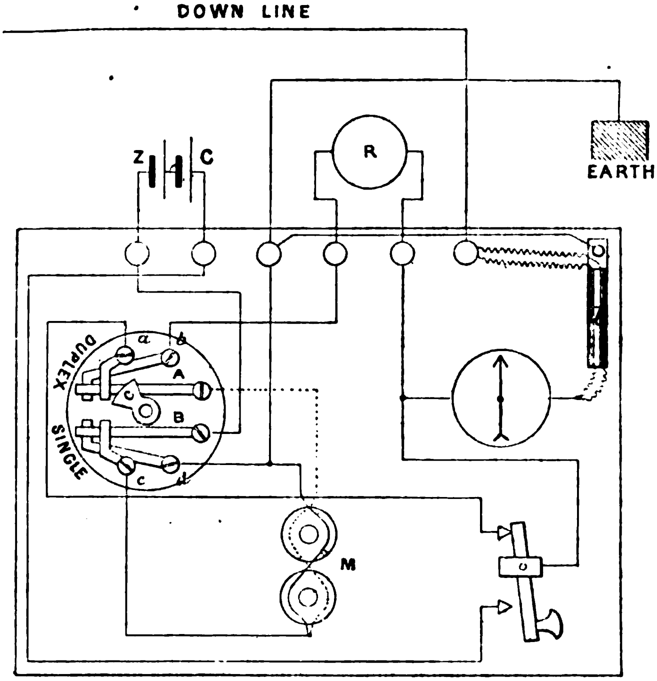


FIG. 49.

For single working, the levers are moved over against contact points *a* and *d*. In this case, when the key is depressed, the whole of the current from the battery passes to line, since the end of the resistance coil is disconnected at the contact point, *b*, and the Zinc pole of the battery is direct to earth through lever, B, and contact point, *d*. If a

current is received from the distant station when the key is at rest, then the current enters through the lever of the key and its back stop, from there it passes to contact point, *a*, thence to earth through the lever, B, and both coils of the electro-magnet, in the directions tending to magnetise the latter.

The Directer writer duplex instrument, in outward appearance, is similar to the ordinary Direct writer (Article IV.), but it has one more terminal, and the switch attached to it.

The actual arrangement of the connections will be seen from fig. 49. The lightning protector, *l*, connections in this case are slightly different from those adopted in the Direct instruments. In the latter the Up line passes through one wire of the protector, and the Down line through the other wire; in the duplex instruments, where the stations are of course never "Intermediate," but always terminal, the two protector-wires are connected together and are in circuit with the line wire, whilst the brass barrel of the same is connected to earth, as shown.

The mechanical form of the switch can be understood from the figure. The brass levers, A, B, are in reality brass springs, which can play up and down between the angle pieces connected to *a*, *b*, *c*, and *d*. These springs normally press upwards towards the angle pieces, *b* and *c*, but the cam, C, which is moved by a handle, on being turned in one direction or the other, slips over and presses down the one spring or the other; in the position shown, it has pressed down the spring, A, against the contact piece, *b*, whilst it has released spring, B, which consequently is pressing against the upper contact piece, *c*.

The connections shown are those for an "Up' station; at a "Down" station, the battery connections will be reversed, the Line and Earth connections remaining the same.

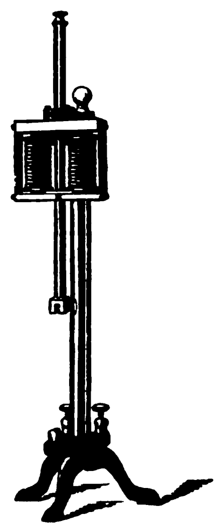
ANDERSON'S PATENT BATTERY.

Mr. R. C. Anderson has recently introduced an improved zinc-carbon battery, which is remarkable for its power and constancy.

Any new form of battery, it is evident, must possess many advantages and great improvements over all previous cells, to enable it to compete with those forms which have long been established and used.

The Leclanché and the manganese cells have each obtained great favour on account of the very slight amount of local action which takes place, thus enabling them to be left unattended for long periods, as in the working of electric house bells. In a certain class of telegraphic work they rapidly polarise and require inconvenient intervals of rest, while the rapid fall in electro-motive force is annoying and troublesome to the operator, and for any work requiring great quantity of current, as, for instance, the electric light, they are quite useless. The Daniell cell and its various modifications, which have been, and are, extensively used for telegraphic purposes, require frequent renewal, and, if unattended for any length of time, become almost useless by deposition of crystals and action on the plates. Many other forms of constant batteries have also been tried, but all have failed in actual work to win the approval of electricians, by reason of various defects; while some are so expensive in first cost, and troublesome and expensive to maintain, as to be out of the market. When a battery of large quantity has been required, either Grove's (platinum and zinc) or Bunsen's (carbon and zinc) combinations have been used. These cells undoubtedly possess the merit of good electro-motive force and low resistance, with freedom from polarisation, but the fumes emitted are so deleterious to everything around that they can only be safely worked in the open air, while they are most troublesome, expensive, and dirty in working, and at the best only last a few hours in action. Many forms have been tried, but none have overcome these defects.

The bi-chromate of potash cell gives good results, but the action is so limited in duration as to render it unsuitable for any practical work, while all



arrangements for causing the exciting fluid to circulate, and thus prolong the action, are both complicated and costly.

These difficulties in the construction and working of galvanic batteries, Mr. R. C. Anderson has, after long and exhaustive experiments, almost entirely overcome, and, in his patented improvements, produced a cell which can be used either as a single or double fluid battery for constant or for occasional work, and in which great electro-motive force is combined with the highest freedom from polarisation and remarkable constancy, while the complete cell compares favourably with any of the forms of batteries hitherto in use, both in simplicity of construction, first cost, and working expenses.

The new battery is made either as a single fluid without porous division, or as a double fluid with porous cell. In either case the elements are carbon and zinc, excited by a mixture of muriatic acid and bi-chromate of potash, with addition of a small quantity of patent compound salts, which together constitute the novel points in the battery.

The single fluid cells are most suitable for any purpose requiring great power with constancy for a period not exceeding ten to fourteen hours.

A single cell of this arrangement, exposing an effective zinc surface of 36 square inches, maintained a current on a closed circuit of 5 ohms resistance, for ten hours without variation, being equal in quantity to two Grove cells, each exposing 30 square inches of zinc surface, thus exhibiting nearly 75 per cent. higher results.

The battery does not give off offensive fumes.

The double fluid battery is a very useful invention. The zinc is placed in the inner or porous cell, in which the excitant is R. C. Anderson's patent salt dissolved in water. The carbon is placed in the outer cell, in which the excitant is a mixture of muriatic acid and bi-chromate of potash solution, with addition of the patent salts.

Owing to its greater internal resistance, the current strength of this battery is less than that of the single fluid form, but its constancy is so far increased that a cell exposing an effective zinc surface of 12 square inches gave a current equal in quantity to three Leclanché cells (or three Daniell's), on a closed circuit, for seventy hours. This power was maintained with slight variation, and only in the last few hours did the electro-motive force diminish.

If used for intermittent work, as in telegraphic or telephonic circuits, it will continue in action from six to eight months without attention.

A peculiarity in the battery exists in the fact that the zinc remains clean and free from deposit, its consumption being remarkably small for the work done.

The electromotive force of these cells is 2·15 volts, and their resistance very low, from the high conducting power of the fluids employed.

We lately had an opportunity of inspecting some of these new batteries at the manufacturers, Messrs. Dale and Crampton, of Little Britain, E.C., and can testify to their efficiency. Thirty of the single fluid cells gave a powerful and steady electric light with one of Messrs. Crampton's electric lamps. These lamps, a figure of which we give, are remarkable for their extreme simplicity and consequent low cost. In principle they are very similar to the Brush lamp. The top carbon slides in a tube between the two bobbins of an electro-magnet, and the armature, which is in two pieces, clutches hold of the top carbon, and then lifts it up, so as to produce the arc.

Fifteen cells of the battery connected to one of Messrs. Dale and Crampton's induction coils, containing 200 yards of primary, and 14 miles of secondary wire, produced a dense 20″ spark, a remarkable performance for a coil of the size.

In the first four months of 1880 the receipts for telegrams in France have been increased by 1,500,000 francs, but the postal department lost one-sixth of that amount. This result shows that owing to the low rate of telegrams in France (½d. per word) and the increased postage (1½d. per letter), telegraphy is gradually taking the place of ordinary letters.

Notes.

The McMahon Telegraphic News Agency, working the patents of the Exchange Telegraph Company, is, we hear, very successful. In reporting all great events it effects a saving of time of from twenty minutes to one and a half hour over the hand-delivered telegrams of the old fashioned systems.

The result of the City and Suburban race, handed in at Epsom at 4.20, was delivered at 4.25; of the Manchester Cup, handed in at 4·20, delivery was effected at 4.27½; and the Derby, which commenced at 3.19, was telegraphed to London and re-transmitted to 300 places in London by 3.37, these places extending from the top of Oxford street to the Tower. In this last instance the rapidity is not only very creditable to the Agency but also to the Post Office department, in conjunction with which the speed was attained.

Telegraphing Extraordinary.—The Superintendent of Telegraphs (Mr. C. Todd, C.M.G.) has kindly supplied us with the following information:—On Sunday morning, the telegraph lines being clear of business, Melbourne and Port Darwin were put in direct communication with each other, the distance between the two places being 2,500 miles. The signals were perfect at each end, the line working splendidly right through, and the replies were instantaneous. The cable was then cleared, and communications exchanged with Singapore, a further distance of 2,200 miles, or 4,700 miles from Melbourne. Replies were received from Singapore in a few seconds, a message being sent and a reply received in the space of one minute from the commencement of the message. The messages had, of course, to be repeated at Port Darwin, but this was done simultaneously, so that little or no time was lost. Port Darwin and Singapore were in direct communication through the duplicate cable recently laid, which avoids the necessity of using the land line through Java. Since the duplicate cable has been submerged the time occupied in the transmission of messages between London and Adelaide is greatly reduced, seldom occupying more than a few hours, and from Adelaide they invariably beat the sun, arriving at their destination in advance of the local time they were handed in.—*South Australian Register.*

General Anson Stager has resigned the office of General Superintendent of the Central Division of the Western Union Telegraph Company, increase of work having rendered it necessary that he should devote the whole of his time to the duties of the vice-presidency of the company.

Mr. George Prescott, for more than ten years past the Electrician of the Western Union Company, has resigned that position to take charge of the Gold and Stock Telegraph Company as vice-president and executive manager. Under Mr. Prescott's administration of the electrical and engineering department, the construction and operation of the lines have been systematised and greater economy introduced. Special attention has been given to economy in the construction and use of batteries, the cost of which has been reduced to about 25 per cent. per mile of line, as compared with that at the time he was appointed electrician, while their efficiency and reliability has been greatly increased. The work of the electrical and engineering department has been transferred to a bureau in the department of vice-president Van Horne. Mr. Prescott has also been elected President of the American Speaking Telephone Company.—*Journal of the Telegraph.*

It is officially announced that on and after June 1 the charge for telegrams to Germany will be reduced from fourpence to threepence for each word.

It is proposed to employ the electric light in lighting the Sheldonian Theatre and the Radcliffe Library, now used as a reading room of the Bodleian Library at Oxford University.

The line of telegraphs between Dalmally and Oban, a distance of 25 miles, was completed recently, and the stations fitted with the necessary apparatus for the transaction of a complete railway telegraphic service. The whole work has been executed by Mr. Dunn, of the Caledonian Railway Company.

Dr. Siemens' paper on "The Dynamo Electric Current in its application to Metallurgy, to Horticulture, and to the transmission of Power," which has been postponed owing to the indisposition of the author, will be read before the Society of Telegraph Engineers on Thursday, June 3rd.

Some satisfactory trials have recently been made with the Brush electric light on board the *Inflexible*. We hear that the system is to be adopted on several of Her Majesty's war vessels.

The *Journal de Physique* contains a description of some experiments of Herr Koch on the so-called electromotograph effect discovered by Edison. When a plate of platinum or palladium is put in contact with a plate of moistened glass and polarised, the friction between the two becomes reduced. Herr Koch measures the amount of this friction in the following manner:—The metal is formed into a small button which forms the lower pivot of a magnetic needle. This pivot rests on the bottom of a glass cup containing a small quantity of water, if now the needle be set oscillating the number of vibrations it will make before coming to rest will represent the amount of friction between the metal pivot and the glass surface on which it rests. If one pole of a battery be connected to the metal pivot and the other pole to a platinum wire dipped in the water, then the amount of friction becomes modified. When the battery connections are such that hydrogen is developed on the pivot, no alteration in the friction is produced; but if oxygen is formed then the friction becomes considerably increased, in the ratio of two to three or four. The increase appears immediately on closing the circuit and disappears immediately on reversing the current, but only slowly diminishes when the circuit is opened. It increases with the electromotive force. Palladium behaves like platinum, but 18-carat gold gave no effect.

M. Marcel Deprez has succeeded in inventing a system by means of which angular velocity may be transmitted electrically to a distance. The apparatus consists of a transmitter with a double commutator, an electro-motor forming the receiver, and two conducting wires (one from each commutator). On the shaft of the transmitter are fixed the two commutators, each of which reverses the current that traverses it twice each turn; but the positions of the shaft corresponding to these inversions do not coincide; they follow each other at intervals of a quarter of a turn. The receiver consists of a permanent magnet or electro-magnet, between the branches of which are two straight electro-magnets, capable of rotating round an axis which coincides with that of the magnet. The currents sent through these electro-magnets from the transmitter produce the required rotatory movement. The currents required to drive the receiver may be generated by a magneto-electric machine or by a battery. For every position of the axis of the transmitter there is one position—and one only—of stable equilibrium for the axis of the receiver. Hence the axis of the receiver follows all the movements of the transmitter; turns at the same rate and in the same direction as the transmitter may be turned; and makes the same number of revolutions precisely to within a quarter of a revolution.

Dr. C. Gore, F.R.S, has recently brought before the Royal Society the results of some preliminary experiments on the Effects of Electric Currents on the Surfaces of Mutual Contact of Aqueous Solutions. In the year 1859 the author made the following experiments, for the purpose of ascertaining whether visible movements, similar to those obtained by passing an electric current through mercury and an aqueous solution, could be obtained by passing a current through the surface of mutual contact of two aqueous liquids alone:—"1st. A definite layer of oil of vitrol was placed beneath a layer of distilled water weakly acidulated with sulphuric acid, and the terminal wires of a voltaic battery immersed in the upper liquid; no visible movements occurred at the boundary line of the two liquids. 2nd. A dense solution of cyanide of potassium was placed in a small glass beaker, a few particles of charcoal sifted upon its surface, and a layer of aqueous ammonia, half an inch deep, carefully poured upon it. A vertical diaphragm of thin sheet gutta-percha was then fixed so as completely to divide the upper liquid into two equal parts; the vessel was placed in a strong light, and two horizontal platinum wire electrodes, from sixty-six freshly charged Smee's cells were immersed one-eighth of an inch deep in the liquid ammonia on each side of the diaphragm. A copious current of electricity circulated, but no movement of the liquids at their mutual boundary line could be detected."

Recently, also, the author made similar experiments but in a much more searching manner, in order to ascertain whether an electric current, passing between two aqueous liquids, affects their diffusion into each other. The essential difference in the form of these experiments from that of the above mentioned one was to concentrate the action of the current upon a very much smaller surface of contact of the liquids, and thus render any visible effect upon their diffusion more manifest. After making several forms of apparatus, in order to obviate certain difficulties of manipulation which arose and were fatal to success, it was found that, when an electric current was passed between the surfaces of mutual contact of certain aqueous solutions of different specific gravities, the boundary line of contact of the two liquids became indefinite at the surface where the current passed from the lighter into the heavier solution, and became sharply defined where the current left the heavier liquid and re-entered the lighter one; and that on reversing the direction of the current several times in succession after suitable intervals of time, these effects were reversed with each such change. Also, in various cases in which the contiguous boundary layers of the two liquids had become mixed, the line of separation of the two solutions became, by the influence of the electric current, as perfect as that between strata of oil and water lying upon each other. In rarer cases two such distinct lines of stratification apeared. Other new phenomena were also observed.

Every practical electrician knows the trouble that is occasioned in battery cells by what is known as "creeping," that is to say, the tendency of the liquid in the cells to deposit crystals on the sides of the jar above the level of the liquid, which crystals act as a

kind of siphon when the crystalline formation reaches the top of the jar, and drain off a quantity of the liquid out of the cells. A correspondent, writing to the American *Journal of the Telegraph*, gives a remedy for this troublesome action; he says:—

"Instead of using oil in battery cells I use tallow, which I think much cleaner and better adapted to the purpose. The tallow should be melted, not sizzling hot, but just enough to liquefy it. A sufficient quantity to form a crust half an inch thick over the surface should be poured into each jar. As tallow hardens immediately upon coming in contact with water, the jar is at once sealed up with a substance easily procured, easily handled, and, if necessary, easily removed. A pound of tallow costing five or six cents will seal up half a dozen jars, and when sealed up in this way they will require very little attention. If it be necessary at any time to add sulphate of copper it can be introduced by merely making a small hole in the crust, which is easily filled up with a little melted tallow. A cell should not be thus sealed up except when in good condition—work it up to its proper stage, then seal it. One great advantage in thus sealing the cell is, that it keeps the edge and sides of the jars clear of the crystallisation which is so annoying, and keeps them clean and nice. I set my local cells alongside my instruments since they have been sealed up, and find them not at all objectionable. Mutton tallow is preferable, but beef tallow will do nearly as well. Of course the cell must have sufficient water to allow of the formation of the crust without its touching the zinc."

THE EFFECT OF LIGHTNING ON TREES.—Our Geneva correspondent writes, under date May 12:—"A few days ago, during a violent thunderstorm, a tall poplar on the Cour de Rive, a street in the upper part of Geneva, was struck by lightning. Directly after the occurrence Professor Colladon, the eminent physicist, and one of the consulting engineers ot the St. Gothard Railway, made a minute examination of the tree, and his observations, more especially as they are opposed to some generally received theories, and relate incidentally to the right construction of lightning conductors, may be not uninteresting to many of your readers. After remarking that his conclusions are based on the careful investigation of sundry similar phenomena, the professor goes on to say that it is not true, as has been commonly supposed, that the gashes (*plaies*) found in the trunk of a tree which has been struck by the electric fluid are the parts with which the lightning first came into contact. The parts first struck are the highest branches, especially those most exposed to the rain. Thence it runs down the smaller branches—affecting almost the whole of them—to the larger ones until it reaches the trunk. These large branches, and above all the trunk, being much worse conductors than the small branches, the passage through them of the fluid produces heat and 'repulsive effects' whereby the bark and sometimes the wood are torn in pieces, the bits being thrown a considerable distance, occasionally more than 50 metres. This theory, says Professor Colladon, is the result of numerous observations. It not infrequently happens that the upper branches and their leaves are destroyed—this is generally the case with oaks, which are often struck—but the leaves and young shoots of poplars and many other trees are such excellent conductors that they do not appear when struck to suffer any notable injury. This rule is so general that, though their trunks may be rent and their bark torn off, not more than two or three poplars out of 100 struck by lightning have their leaves shrivelled or even discoloured. This induction finds full confirmation in the condition of the poplar on the Cour de Rive, for it is not often in Switzerland that trees are struck by lightning early in May, when their leaves are young and tender. In this instance the principal and highest branch of the tree, on its south-western side, was the first with which the fluid came in contact. Its leaves and twigs, neither withered nor tarnished, were torn into minute fragments and scattered about on the ground. This was the effect, not of the lightning, but of the concussion of air, exactly as if there had been an explosion of dynamite or gunpowder; and the windows of two houses close by were broken in the same manner and by the same cause. Before even the professor saw the tree he had expected to find not far from it a spring or a stream of water; for the presence of water near the root of a tree is often the determining cause of its attraction for the electric fluid. In effect the professor found, five metres from the poplar, on its north side, a leaden water-pipe, and close to it a drain filled with waste water from a laundry. The principal fissure in the tree was also on the north side; and half way between it and the water-pipe a plank lying on the ground had been pierced by a concentrated jet of the electric fluid as it flashed towards the pipe by the shortest route. Many trees, especially poplars, may be compared to buildings the lightning conductors of which are not continued to the ground. A building of this sort, if struck by the electric fluid, would in all probability remain intact in its upper part and be seriously damaged beneath the part where the conductor ceased. Hence, by far the safest part of a tree during a thunder-storm would be its topmost branches. This explains why birds are so rarely killed and their nests so seldom disturbed by lightning, while persons who have sought shelter under the spreading branches of trees are so often struck. The electric fluid, finding the trunk and the larger branches imperfect conductors, is easily attracted by surrounding bodies, whether they be bushes or human bodies. Large trees, especially tall poplars, placed near a house may serve as very efficient lightning conductors, but always on the indispensable condition that there is no well or running water on the opposite side of the house, for in that case the electric fluid, if it struck the tree, might pass through the building on its way to the water. In 1864 a house at Lancy almost in contact with a poplar on one side and a marsh on the other was set on fire by lightning, and the path of the electric fluid, from the point at which it left the tree, across the roof of the building to the marsh, could be distinctly traced. Hence, in erecting lightning conductors it is desirable that their lower extremities should terminate in a strean, a well, or a piece of damp ground. The plant most sensible to electricity is the vine. When a stroke of lightning falls in a vineyard the leaves affected are turned red-brown or deep green, a circumstance which shows, in the opinion of Professor Colladon, that the electric fluid descends in a sheet or shower, and not in a single point, the number of vines touched—sometime several hundred—by a single *coup* proving that the lightning had covered a wide area. This fact lends additional confirmation to the theory that lightning disperses itself among the smaller branches of trees and over ground covered by vegetation."—*Times.*

THE CITY AND GUILDS OF LONDON INSTITUTE.—A Laboratory and Tutorial course on Electrical Engineering will be held at this Institute every Tuesday evening from 7 to 9 p.m., commencing on May 25th. The course will be under the direction of Professor Ayrton.

AN electrical arrangement for automatically recording the notes played upon a piano was recently described to the Paris Physical Society, by MM. Leclerc and Vincent.

Correspondence.

BROOKS' UNDERGROUND TELEGRAPH SYSTEM.

To the Editor of The Telegraphic Journal.

Dear Sir,—Yesterday I was at Versailles, and tested four of the conductors referred to by Mr. Aylmer. No. 1, after five minutes' electrification, gave an insulation resistance of 203 megohms per kilometre. No. 22, after five minutes, 254 megohms. No. 12, after one minute, 135; after two minutes, 193; after five minutes, 254. The insulation of No. 12 was taken again after being disconnected from battery ten minutes, and the other conductors connected to earth with the following results:—After one minute, 176 megohms; two minutes, 203; three minutes, 226; four minutes, 256; and five minutes, 256. These tests were taken between twelve and two o'clock. Temperature in the shade 80° Fahrenheit. The pipe containing the cable is covered with about a foot of gravel, the latter exposed to the sun. Mean temperature of the cable is supposed to be about 80° Fahrenheit.

Very truly yours,
DAVID BROOKS.

Hotel Meurice.
Paris, May 26th, 1880.

My Dear Sir,—I have much pleasure in complying with your request to give you the results of the tests I made on the 14th inst. of the length of your liquid insulated cable, which you laid down at Versailles in November last:—

No. of Conductor.	Insulation Resistance.		Electrostatic Capacity.	
1	178·5	megohms per kilom.	0·106	microfarads per kilom.
2	238·0	"	·087	"
3	223·1	"	·087	"
4	238·0	"	·087	"
5	198·3	"	·106	"
6	198·3	"	·106	"
7	198·3	"	·106	"
8	198·3	"	·106	"
9	223·1	"	·109	"
10	223·1	"	·109	"
11	223·1	"	·109	"
12	223·1	"	·106	"
13	223·1	"	·106	"
14	210·0	"	·106	"
15	223·1	"	·106	"
16	238·0	"	·109	"
17	223·1	"	·109	"
18	223·1	"	·106	"
19	223·1	"	·106	"
20	223·1	"	·109	"
21	223·1	"	·109	"
22	223·1	"	·106	"

The insulation tests repeated on each wire, when, at the same time, the ends of all the other wires were put to earth, gave practically similar results.

I may mention that, as the cable showed considerable absorption on slowness of full electrification, the readings for insulation were all taken after five minutes' electrification, and those for electrostatic capacity by discharge after one minute's electrification.

I am, my dear Sir,
Yours very faithfully,
Paris, May 25, 1880. J. AYLMER.

ANDRÉ'S LAMP AT THE ROYAL EXCHANGE RESTAURANT.

Dear Sir,—Whilst strolling down Cheapside yesterday evening with a friend, he suggested to me that we should go to the Restaurant under the Royal Exchange Building, to see the André lamps, said to be there used for illumination. On arriving at the foot of the stairs, my friend, addressing himself to a young gentleman who stood by, asked a few questions as to the number of lamps used, &c. He replied that he did not know much about the matter, but that his uncle, who, I think he said, was managing proprietor, would soon be there, and would give us every information. That gentleman having arrived, he kindly stated in answer to our question, that he was very well satisfied with the light, and he claimed for it advantages over the *Jablochkoff* and all other systems on account of the *diffusion* of light obtained by it, and also eulogised it on the score of its *sombre* quality. He then directed his nephew to conduct us to the machine-room, on reaching which we were handed over to an attendant, who informed us that the engine was a 12 horse-power gas engine, and that two machines were working the lights then burning. I remarked that there were *three* being driven (out of five which were there), but he said that one was not in use. We were still conversing with this attendant when four or five individuals came towards us, two of whom intercepted our view of the machines by standing in the doorway, and one then stepped into the machine room and closed the door thereof in our faces, with the remark, that, "he must close the door to shut in the *noise*." We considered ourselves completely hustled off the scene, and are at a loss to understand why, if there is nothing there to be ashamed of any one seeing. Is the power absorbed by the lamps so tremendous that it must be kept dark? The 8 lamps I saw burning seemed to give nice little lights, in power ranging from about ¾ to 1 gas burner (12 to 16 candles), and did not flicker more than electric lights usually do when requiring slight regulation. I am indebted to the courtesy of the gentleman referred to for the permission given to inspect the lights, but he unfortunately was not present when the treatment I have described above was accorded to my friend, and

Yours truly,
May 27, 1880. ON LOOKER.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

An ordinary general meeting of this Society was held on Wednesday, May 26, Mr. W. H. Preece, President, in the chair. The minutes of the last general meeting having been read, and a list of new and proposed members read,

Mr. Edward Graves read a paper on "A Decade in the History of English Telegraphy." The author commenced his paper by stating that he only proposed to deal with English telegraphy proper, exclusive entirely of the submarine cables used for connection between our islands and the continents of Europe and America.

In 1846 the first telegraph company in England was incorporated; in 1850-51, the British Telegraph Company, the European Telegraph Company, and the Magnetic Telegraph Company all came into existence. After various vicissitudes, these companies, or what remained of them, amalgamated under the name of the British and Irish Magnetic Telegraph Company. This was in 1857.

Later still, in 1860 or 1861, the United Kingdom Telegraph Company, which had been projected many years before, assumed a real existence. This company differed from the former companies, inasmuch that it was wholly unconnected with railways.

Then various local companies were established.

The London District Company, afterwards termed the London Provincial Company, had its sphere in the metropolis and suburbs.

The Bonelli Telegraph Company, between Manchester and Liverpool.

The Economic Telegraph Company, and several others whose existence was ultimately unprofitable, and whose careers were brought to a more or less untimely end.

About 1861 the Universal Private Telegraph Company was started.

In 1869 there were existing in the United Kingdom no less than twenty-nine separate undertakings specially devoted to the transmission of telegraph messages, wholly independent of railway companies, who employed their wires secondarily for the same purpose.

There were certain railways which were carrying on telegraph business on a comparatively large scale. The districts occupied, for example, by the South Eastern Railway, London Chatham and Dover Railway, the London Brighton and South Coast Railway, and the North British Railway Company, had either never been wholly handed over to the telegraph companies, or had been taken out of their hands, so far as it was in the power of the railway companies to do so, prior to the date referred to, *i.e.*, 1869.

These railway companies were compensated for the actual business they were doing, and others obtained compensation in consideration of the loss of their reversionary power of carrying on such business, *i.e.*, when free from their engagements to telegraph companies.

In some instances a telegraph company and a railway company treated with each other as independent powers, but worked together.

In 1868 the Post Office were authorised to buy up and extinguish existing interests in commercial telegraphy.

The Telegraph Act of 1868 did not contemplate granting a monopoly to the Post Office, but before the Money Bill to make good the purchase was authorised in 1869, the political authorities had determined that a monopoly of the right of sending telegrams for money was necessary, and it was therefore acquired.

The year 1869, the last complete year of the telegraph companies, was, in some sense, a period of stagnation. The arrangements made with the Government practically put an end to their future career in 1868, and until the purchase was completed their main object was to spend as little as possible, so as to realise the utmost immediate profits.

To make a fair comparison, therefore, it is proposed to take the period when the active exertions of the companies were suspended, and compare its results with those attained in the year 1879, when for ten years the commercial telegraphs of the country had been transferred to the State.

In 1869 the lines of telegraph available for public use extended from Penzance to Wick, and from Lowestoft to Galway. In fact, the succeeding ten years have only carried them on to Scilly and the Shetlands, so far as regards the main north and south routes. But while the country was traversed by electric lines it was not covered by them: they were very widely severed in some districts. Whole counties were dependent upon a single thread of communication, and towns far from a railway were in many instances utterly ignored. The telegraph had penetrated to places where commercial activity was rife, and whence profits could be drawn; but it had not been utilised for the benefit of rural districts, nor had it as a rule been established where commercial success could not be reckoned upon. In fact, the only chance of finding a telegraph office in a village was in the event of its also being a railway station where there was a telegraph available primarily for railway purposes, or of a trunk road line passing through to some large seat of commerce, upon which the company had established an intermediate office.

In 1879 the country was almost uniformly dotted over with telegraph offices. Commercial considerations alone have not been kept in view, and telegraphic facilities have been given in many instances to very small communities far from any commercial centre.

In 1869 the total number of telegraph offices was 2,488, railway stations open for telegraph business included.

In 1879 it had reached 5,331.

But the increase of convenience is in reality much greater than is expressed by these figures.

In 1869 there were three, and in some cases four companies all competing with each other, and all having offices in the same quarters of large towns, very often close together. So that, although a town might contain three telegraph offices, the accommodation to the inhabitants was really only that of one.

Under the present *régime* all this is changed; and to express the difference in the accommodation given, at least 500 offices should be deducted from the number of those formerly existing.

In 1869 the total number of messages transmitted by the companies was, as far as can be estimated, from 6,000,000 to 6,500,000.

In making comparisons, the fact has often been overlooked that each company counted the number of messages passing over its own wires without regard to the fact that the same messages were counted again on the wires of another company. In some cases a message may have been counted three times over, thus the total number of messages transferred from one company to another was very large, and in consequence the published figures on the point are vitiated by a great inaccuracy.

The total number of messages transmitted over the English land lines in 1879 (more exactly for the financial year ending 31st March, 1880) was 26,547,137, being an increase of more than fourfold over those of the corresponding period ten years ago.

In 1869 the total number of miles of wires used exclusively for commercial traffic was under 50,000, some part of which length was by the provisions of the Acts of 1868 transferred to railway companies upon the acquisition of the telegraphs by the State, and does not now count as commercial wire.

In addition, the telegraph companies had the partial or secondary use of the railway wires.

(*To be continued.*)

PHYSICAL SOCIETY.

The annual holiday meeting of this Society was held on May 22nd, at Cambridge. On arrival there the party partook of luncheon in a hall of St. John's College, which had been kindly arranged for the purpose by the College authorities. Prof. W. G. Adams, occupied the chair; and Mr. Warren de la Rue proposed a vote of thanks to the Master and Senior Fellows of the College for providing the hall. The vote was heartily accorded by the members; and after some remarks from Prof. Adams the party proceeded to the Cavendish Laboratory, where Lord Rayleigh, as Vice-President of the Society, presided. The routine business of the

meeting being waived, Lord RAYLEIGH described a plan for limiting the slit of a telescope so as to alter the angular interval with which it can deal. The interval is measured by means of a grating formed by winding a fine wire round two parallel screws of very fine thread.

Mr. SHAW exhibited a modification of Veinholdt's apparatus for distilling mercury, by which a kilogram of mercury can be distilled per hour.

Mr. SYDNEY TAYLOR exhibited a device for showing the motion of the particles of water in the transmission of a surface wave. Sixteen discs were arranged in single file, each having a white spot on its face, and on turning a handle the discs rotated so that the spots, which represented particles of water, moved so as to present a wave motion to the eye. Mr. TAYLOR also showed a manometric flame apparatus for exhibiting to the eye the difference of phase between two musical notes. This consisted in two bent tubes into which the notes were sounded, and capable of being lengthened or shortened by hand like the pipes of a trombone. Opposite the ends of each of these tubes a sensitive flame was placed and a rotating mirror showed the disturbance produced in the flames by the two different notes. A third flame exhibited the joint effect of the two notes. When the tubes were silent the images of the flames on the revolving mirror were seen as plane bands, but when notes were sounded into the tubes they became serrated, and the serrations were like or unlike according as the phases of the notes were like or unlike.

Mr. POYNTING exhibited a plan for altering the plane of polarisation of the two halves of a pencil of rays from the polariser, so that half the field may be made to appear dark when the other is bright, or both of equal brightness at will.

Mr. GLAZEBROOK described a method of measuring the rotation of the plane of polarisation of light by means of two spectra giving dark lines made to coincide.

Lord RAYLEIGH described a plan for demonstrating that yellow colour can be formed by combining red and blue together. He mixes a red solution of chromate of potash with a blue solution of litmus, and on filling it into a glass cell of a certain thickness the light transmitted through it is seen to be yellow. Plates of glass coated with gelatine impregnated with litmus and gelatine impregnated with chromate of potash and placed side by side also transmit yellow light. Lord RAYLEIGH finds, however, that the eyes of different persons vary considerably in their power of appreciating the tinge of the transmitted yellow; one deeming it greenish, another reddish, while a third considers it pure yellow. This peculiarity is not to be confounded with colour blindness, since all three persons would distinguish the red and green components accurately. Lord RAYLEIGH also exhibited a colour-box, based on the Newtonian principle, first carried out by the late Professor Clerk-Maxwell, but of a small size.

Sir W. THOMSON then proposed a vote of thanks to Lord Rayleigh, which was seconded by Prof. W. G. ADAMS, and the meeting then dispersed to examine the apparatus and appointments of the Cavendish Laboratory.

New Patents—1880.

1934. "Instruments or appliances for adjusting and correcting deviations in the mariner's compass." H. J. THATCHER. Dated May 11.

1942. "Improvements in and relating to apparatus for transmitting fire-alarm and other signals." W. P. THOMPSON. (Communicated by J. F. M. Bartelous.) Dated May 12.

1954. "Improvements in sound articulators or instruments to assist the sense of hearing through the teeth or bones of the head." W. CLARK. (Communicated by O. D. Orvis.) Dated May 12.

1958. "Improvements in and relating to telephonic exchange systems." J. H. JOHNSON. (Communicated by G. L. Anders and T. A. Watson.) Dated May 12.

1960. "Insulators for supporting and securing telegraph and other wires." G. WELLS and A. GILBERT. Dated May 13.

1998. "Magneto-electric machines." W. R. LAKE. (Communicated by C. A. Seeley.) Dated May 14. (Complete.)

2020. "Means and apparatus for continuous electrolytic action." C. D. ABLEL. (Communicated by L. Wollheim.) Dated May 18.

2037. "Electric lamps." W. CLARK. (Communicated by P. Drew.) Dated May 19. (Complete.)

2049. "Signalling on railways and apparatus therefor." W. T. C. PRATT. Dated May 20.

2114. "An improved manner of and mechanism for perforating paper for telegraphic purposes." W. R. LAKE. (Communicated by T. M. Foote and F. Anderson.) Dated May 24. (Complete.)

2136. "Improvements in and relating to call or signal apparatus for telephonic or telegraphic purposes." W. R. LAKE. (Communicated by C. S. Eaton.) Dated May 25. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

3927. "Galvano-plastic process." W. E. GEDGE. (A communication from Cyrille Bonaz.) Dated Sept. 30. 6d. Relates to a process by which it is proposed to render easy and practical the reproduction in a single piece of all kinds of objects or articles in alto-relievo. For the purpose of bringing the positive current into the mould either an anode jointed or linked like a chain, or an anode formed of a continuous metal wire or of a plate, also metallic, is used. This chain, wire, or plate, is surrounded with a suitable insulating substance incorruptible or unalterable in the bath, and having numerous openings. These anodes, in sufficient number to fill the entire cavity of the mould, are then introduced into it, and the whole being carried to the reduction bath, the anode and the mould being connected the one with the positive and the other with the negative pole of the source of electricity, the metallic solution decomposes, and the metal deposits over the inside of the mould.

3954. "Medico-galvanic electrode." ISAAC LOUIS PULVERMACHER. Dated October 2. 2d. Consists of a medico-galvanic electrode, magnetic at will. Triangular thin copper and zinc plates are fixed in alternate order on one or more superposed circular discs of thick stiff cotton, linen, or woollen cloth, or cardboard, by overlapping edges at the inner and outer edges. The central hole thus formed receives a metallic piece, having a pin in its centre, the whole being similar to a drawing pin, the head of which is slightly larger than the central hole in the apparatus or appliance. The centre pin is on its thicker or lower portion threaded to receive another disc, of the same size as the "head," and acting as a nut. To render this appliance magnetic at will, a circular magnet may be inserted between the two cloth discs during manufacture. *(Provisional only.)*

4189. "Electric telegraph terminal and shackle insulators." C. E. Crighton. Dated October 16. 6d. Has for its object the production of a terminal or shackle insulator, so constructed as to render the insulation of electricity more perfect than is attainable by the insulators at present used for terminating and shackling the telegraph wires of aerial lines. To the horizontal arm carried by the telegraph post is attached an insulated hollow conical body by means of a metal encircling strap and bolts, around which body is placed another insulating body or shed, which partially encloses the former, and is attached thereto by cement or otherwise. Through the centre of these parts so combined passes a conducting rod or bolt for forming the connection between the subterraneous wire and the aerial wire and receiving the strain of the latter. The central body, before mentioned, is provided upon a portion of its length with alternate annular or surrounding recesses and projections, the object being to retard the passage of rain or moisture from the conducting rod or bolt to the strap, which attaches the insulator proper to the horizontal arm. In the case of shackle insulators, as no connection with a subterranean wire is required, the bolt and its appurtenances are modified, as will be well understood. The claims are four in number, first—a terminal insulator, forming the connection between the subterraneous wire and the aerial wire in the interior of the insulator. Secondly, in a terminal or shackle insulator, the combination of an insulating hollow body, conical on its interior and exterior, a metal encircling strap with attaching bolts or connections to a telegraph arm, and an internal conical plug for receiving the strain of the aerial wire. Thirdly, in a terminal or shackle insulator, the employment of an insulating hollow conical body enclosing a conducting rod or bolt for receiving the strain of the aerial wire, the said hollow conical body having alternate annular or surrounding recesses and projections for preventing the continuity of damp. Fourthly, the general arrangement and combination of parts.

City Notes.

Old Broad Street, May 28th, 1880.

German Union Telegraph and Trust Company.—The ninth ordinary general meeting of the above Company was held on May 11th at the City Terminus Hotel, Sir James Anderson presiding. The report for the year ending the 1st instant stated that the total receipts during the year amounted to £12,227 17s. 6d., which, with a balance of £40 4s. 5d. carried forward from last account, made a total of £12,268 1s. 11d. The working expenses for the same period amounted to £462 13s. 3d., leaving a balance of £11,805 8s. 8d. Out of this amount an interim dividend of 5s. 9d. per share was distributed on the 21st January last, and the directors now begged to recommend the payment of a further dividend of 6s. per share, making a total distribution for the year of 11s. 9d. per share, free of income tax, or at the rate of £5 17s. 6d. per annum upon the capital of the Company, and the directors had also written off £74 17s. 3d. from the expenses of formation of the Company, leaving a balance of £51 1s. 5d. to be carried over to the next account. The Company's cable and land lines remained in good order and condition, and business during the last year had been going on in a satisfactory manner. The Telegraph Conference, held last year in London, had led to the introduction of some important changes, such as the general introduction of the one word rate, and the reduction of tariffs, which so far had led to a diminution of revenue. The Chairman moved the adoption of the report and accounts and the payment forthwith of the dividend recommended. In doing so, he referred to the origin of the Company, which he said was started as a purely German company. At the instance of the leading shareholders, however, it had been made as far as possible an English company, but the English board were only the agents of the Berlin directors. The work of the Company in London was really done by the Submarine Company. The Anglo-American Company allowed them a certain rebate on messages transmitted over their line until the German Union dividend of itself amounted to 10 per cent. The real point in the report was that besides paying a fairly good dividend they had a reserve fund of £12,800, and a renewal fund of £6,280. He thought the Company might therefore be considered a good one. Mr. H. G. Erichsen seconded the motion, and it was carried unanimously, and the retiring director and auditor were re-elected. The proceedings then closed in the usual manner.

Reuter's Telegram Company, Limited.—The sixteenth ordinary general meeting of the shareholders of this Company was held on May 19th at the Company's offices, 24, Old Jewry, for the reception of the report and balance-sheet, the declaration of a dividend, and the election of a director and auditors. Colonel James Holland, the chairman of the Company, presided. The report stated that the net profits for the year ending the 31st December last amounted to £7,101 4s. 4d. including £113 9s. 4d. brought forward from the last account. A dividend of 8s. per share, or 5 per cent., was declared, which, with the interim dividend of 2½ per cent. paid in October last, made a total of 7½ per cent. for the year. Fifteen hundred pounds was added to the reserve fund, and the balance of £108 14s. 9d. was carried forward. The Chairman, in moving the adoption of the report, said that the profits of the year had amounted to nearly 10 per cent., which, having regard to the general depression of trade, was, he thought, very satisfactory, and there was no reason to suppose that the success of the Company would not continue. The report was adopted, and Mr. Stopford, a retiring director, was re-elected. The auditors, Messrs. Quilter, Ball, Crosbie, and Co., were also re-elected. The lease of the Company's offices expiring at the end of the present year, the directors have decided on purchasing the freehold. For the purpose of enabling them to do this an extraordinary meeting was then held, at which a resolution proposed by the Chairman, and seconded by Baron De Reuter, authorising the directors to raise the sum of £10,000, for the purpose of completing the purchase of the Company's offices, and for other purposes, was carried unanimously. It was stated that the price to be paid for the premises was £13,000, of which £6,000 would be paid out of the reserve fund, and the remaining £7,000 out of the £10,000 which it was proposed to take power to borrow. A vote of thanks to the chairman brought the proceedings to a close.

London Platino-Brazilian Telegraph Company, Limited.—The ordinary general meeting of the shareholders of this Company was held on May 25th, at the offices, Old Broad-street, Mr. J. Pender, M.P., in the chair. The report stated that the accounts for nine months, ending March 31 last, showed that, after setting aside a sum of £1,200 for the reserve fund, and charging the interest on the debentures, there remained a net revenue of £5,480 17s. 9d., to which was added the balance of £5,719 4s. carried forward from July last,

making a total of £11,200 1s. 9d. to the credit of revenue account. Out of this the directors recommended the declaration of a dividend of 2s. 6d. per share, free of income tax, which would absorb £4,768 10s. leaving £6,431 11s. 9d. to be carried forward, pending the collection of the debt due from the Uruguay Government. The transfer of the assets and property of the Company from the Brazilian Company to the English Company had been completed, and nearly all the shares had been sent in for exchange and certificates of the English Company issued to the shareholders. In consequence of the provision of the articles of association that the general meetings of this Company should be held in May, it had been found necessary to make up the present accounts for a period of nine months. In future an interim half-yearly dividend would be declared by the board, and the yearly accounts would be made up and presented at the general meeting in May, when a final distribution would be made. The Company's submarine and land lines were in good order. The Chairman, in moving the adoption of the report, said that this was nearly the first meeting since the Company was constituted an English company, and it might be said their affairs were now fully under the management of the present board. Looking to the improved position of the Western Brazilian Company, their prospects were decidedly better. They were likely to get £20,000 this year, against £17,000 during the past two years. They had received a telegram from their agent abroad to the effect that £1,000 had been remitted, but whether it was towards the reduction of the Government debt or not they did not yet know. It was, however, an evidence of growing vitality. If the Government would only keep up to the mark their earnings would show a much better result; but, unfortunately, their arrangements with the Government were such that they were obliged to carry on the traffic whether it paid or not. Since the present directors came into office the revenue of the land lines showed a steady growth. The resolution was seconded and carried unanimously, and the dividend of 2s. 6d. per share having been declared, Mr. J. Pender, M.P., the retiring director, was unanimously re-elected. The retiring auditors having been also re-elected, a vote of thanks to the chairman closed the meeting.

THE WEST COAST OF AMERICA TELEGRAPH COMPANY, LIMITED.—Notice is given that the third ordinary general meeting of the Company (adjourned from the 23rd day of April, 1880) will be held on Friday, the 4th day of June, 1880, at the Cannon Street Hotel, in the City of London, at 12 o'clock noon. In consequence of the war, the final accounts from the stations on the West Coast have not yet been received, but they may arrive by the mail of the 28th inst., in which case every effort will be used to complete the accounts for the past year, for submission to the shareholders at this meeting. Mr. Knowles and Mr. Gray are the directors retiring by rotation, and being eligible, offer themselves for re-election. The auditors, Messrs. C. F. Kemp, Ford, & Co., Public Accountants, also retire and offer themselves for re-election.

The following are the final quotations of telegraphs:—Anglo-American Limited, 62⅞-63⅛; Do., Preferred, 92-93; Ditto, Deferred, 34⅜-35; Black Sea, Limited, ——; Brazilian Submarine, Limited, 8¼-8¾; Cuba, Limited, 9-9½; Cuba, Limited, 10 per cent. Preference, 15¾-16¼; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 10¾-11¼; Direct United States Cable, Limited, 1877, 11⅜-11⅝; Scrip of Debentures, 100-102; Do., £50 paid, par-2 pm.; Eastern, Limited, 8⅞-9⅛; Eastern 6 per cent. Preference, 12¼-12¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 101-104; Eastern 5 per cent. Debentures, repayable August, 1887, 101-103; Eastern, 5 per cent., repayable Aug., 1899, 102-104; Eastern Extension, Australasian and China, Limited, 9-9¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 107-110; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 102-104; Ditto, registered, repayable 1900, 102-105; German Union Telegraph and Trust, 8¾-9¼; Globe Telegraph and Trust, Limited, 5⅞-6⅛; Globe, 6 per cent. Preference, 11⅞-12⅛; Great Northern, 9⅜-9⅞; Indo-European, Limited, 23-24; London Platino-Brazilian, Limited, 4⅜-5; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 2¾-3¼; Reuter's Limited, 9⅞-10⅜; Submarine, 230-240; Submarine Scrip, 2⅜-2⅝; West Coast of America, Limited, 1½-2; West India and Panama, Limited, 1⅜-1⅝; Ditto, 6 per cent. First Preference, 7¼-7¾; Ditto, ditto, Second Preference, 6⅝-7; Western and Brazilian, Limited, 6⅜-6⅞; Ditto, 6 per cent. Debentures "A," 100-103, Ditto, ditto, ditto, "B," 100-103; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 117-122; Ditto, 6 per cent. Sterling Bonds, 103-105; Telegraph Construction and Maintenance, Limited, 33½-34 Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus trust Cerificates, 3¼-3⅝; India Rubber Company, 14-14⅜; Ditto 6 per cent. Debenture, 104-106.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,216.
	£	£	£	£	£	£	£	£	£	£	£	£	£
April, 1880 ...	*	a 15,525	3,100	... ...	*	44,748	24,342	18,360	... ...	*	... ...	13,402	4,591
April, 1879 ...	45,540	12,885	3,140	803	15,180	37,846	21,060	16,299	... ...	10,195	4,225	10,526	5,240
Increase	... ...	2,640	... ...	... ...	... ...	6,902	3,282	2,061	... ...	... ...	... ...	2,876	... ...
Decrease	... ...	... ..	40	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	649

* Publication of receipts temporarily suspended. a Five weeks compared with one calendar month.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

Vol. VIII.—No. 177.

THE TELEPHONE COMPANIES.

The recent Extraordinary General Meetings of the Telephone Company and the Edison Telephone Company, called for the purpose of considering whether an amalgamation of the two enterprises should be effected, must have been watched with considerable interest by the commercial public. The question involved, affects, to a considerable extent, the conveniences which the telephone exchange systems offer. Looking to the wonderful success which the telephonic system has had in America, it is but natural that efforts should be made by those who have plenty of capital at their command in this country to embark the same in enterprises connected with the new branch of telegraphy, and which seem to offer a good prospect of returning handsome dividends.

The long commercial depression which has so seriously affected the prosperity of the country can hardly yet be said to have shown certain signs of passing away, and inasmuch as it has, more or less, affected every branch of trade, the present time is inopportune for judging of the chances of future success which may attend the telephone companies. That every effort is being made to give the systems as wide a scope as possible must be evident to every one, as the network of wires which stretches all over the metropolis, is daily, we might say hourly, growing larger in extent and more offensive, not to say alarming, to the sight. This huge cobweb owes its origin almost entirely to the busy spiders of the telephone companies. Considering the outcry which has been more than once raised against the use of aerial wires, not only on account of their unsightliness, but also on account of the accidents to which they expose the traffic of the streets, it is somewhat surprising that more has not been said on the subject. The Post Office are slowly but surely removing these overhead wires and substituting underground work, but the telephone companies are very quickly making up for this change in the right direction, by putting up ten wires for every one removed by the Post Office. Whether they will be allowed to go on unchecked is, we think, hardly a doubtful question; but the British public has not yet fairly woke up to protest against the disfigurement of our streets. Perhaps when a few more accidents happen they will do so. In the mean time there is a grand opening for an enterprising man to devise a cheap and efficient system of underground wires—perhaps Mr. Brooks will move in the matter; but the difficulties of inductive interference have yet to be overcome.

It can hardly be doubted that the telephone will play a very important part in commercial transactions, and the extent to which it will be used, will, of course, depend in a great measure upon the cheapness with which the power of intercommunication between offices can be afforded. The existence of two or more telegraph companies, each of which undertook, either individually or jointly, to convey a message to any particular locality, involved no greater trouble or expense to the sender of a message than would have been the case if all the work had been carried on by a single company; indeed, the fact of the companies being rivals, as regards the means of communication between large towns, acted as a healthy stimulus, and was advantageous to the public, for each company knew that if there were any delay in getting off the message work, that work would be put into the hands of their more expeditious rival.

In the case of the telephone exchange systems, the conditions are different. The element of delay is altogether absent; one renter can communicate with another immediately, or he must wait till the other is disengaged: there is no intermediate course. The fact, however, of one company having its exchange in communication with one set of renters, and the second company with another, is quite a different affair. It means that the two sets are cut off from communication with each other unless a double rental is paid by each renter. This, it is needless to say, would not be approved of, and the very fact of the difficulty existing would deter many commercial men from subscribing to either company. If the two companies amalgamated, the objection would cease to exist, and very many persons who now hold back would be certain to become subscribers, to the great advantage of the shareholders.

The determination to unite the two companies referred to having been carried unanimously at the two meetings, those interested in the success of the telephone exchange system have great cause for congratulation.

It will gratify electricians to know that Professor David Edward Hughes has been elected a Fellow of the Royal Society.

ON SOME THERMAL EFFECTS OF ELECTRIC CURRENTS.*

By WILLIAM HENRY PREECE, General Post Office.

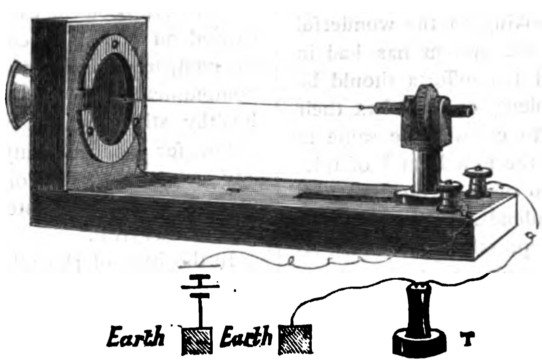
I HAVE been engaged for some time past in experimenting on the thermal effects of electric currents, but the final results of those experiments are not sufficiently ripe at present to justify my bringing them before the Royal Society. I have, however, obtained one result which I believe to be sufficiently novel to justify a short preliminary note.

The most striking facts elicited by these experiments are :—

1. The extreme rapidity with which thin wires acquire and lose their increased temperature.

2. The excessive sensibility to linear expansion which fine wires of high resistance evince.

Now as the rate of heating, and therefore of expansion and contraction, varies very nearly directly as the increment or decrement of the currents, when these variations are very small, it occurred to me that if a long wire of small diameter and high resistance were attached to a sounding board, or to the centre of a disc (such as one of those used for telephones and phonographs) and it formed part of a circuit conveying telephonic currents, sonorous vibrations ought to be reproduced.



The sketch shows the arrangement of the apparatus used for the experiment.

It consists of a stout base of mahogany, on which a brass support was attached so that it could slide and be fixed at any distance from the upright at the further end of the base board.

A disc of thin paper, and then of thin iron, was mounted on the upright.

The wire experimented upon had its ends connected to terminals on the wooden base, so that it could be inserted in a circuit consisting of a microphone transmitter, T, and a battery of six bichromate of potash cells in another room out of hearing.

A platinum wire of 0·003 inch diameter and six inches long from end to end was first used, and the sonorous effects were most marked and encouraging, when the microphone transmitter, T, was spoken into. The articulation, though muffled, was clear, and words could easily be heard.

1. Experiments were first made to determine the length which gave the loudest sound and the clearest articulation, and, after repeated trials with every variation of length from one inch to six feet, it was found that a wire six inches long gave the maximum effect.

2. Experiments were then made to determine the diameter of the wire that gave the best effect, and after repeated trials with every gauge drawn from 0·0005 inch to 0·005 inch, it was found that wire of the diameter 0·001 inch gave the best effect.

3. Experiments were then tried with wires six inches in length and 0·001 inch diameter of different materials, viz., gold, iron, aluminium, silver, copper, palladium, and platinum, and they came out in the following order of merit :—

Platinum	Very clear.
Aluminium	Very variable.
Palladium	Clear.
Iron	Clear.
Copper	Faint.
Silver	Faint.
Gold	Very poor.

4. The effect of mechanical strain was tried. It was found not to vary the effect. When once the requisite tension, which varied with each metal, was obtained, further tightening up did not vary the clearness or loudness of articulation.

Gold would scarcely bear the tension required to reproduce sonorous vibrations, hence its low position.

5. Very thin carbon pencil, ·0625 inch diameter, was tried under compression and under tension, but no effect whatever was experienced unless a bad joint was made, when at once a faint microphonic effect was apparent.

6. No sibilant sounds whatever could be reproduced.

7. That the effect was due to heating and cooling, was shown by the fact that it was possible to increase the current to such a strength as to render the temperature of the wire sensible to the touch,

* Read before the Royal Society, May 27th, 1880.

and then to make its elongation and contraction by low sounds evident to the eye.

It therefore appears from these experiments, that wires conveying those currents of electricity which are required for telephonic purposes expand and contract as they are heated and cooled, and as the variations in the strength of the current are small compared with the strength of the current itself, the expansion and contraction vary in the same ratio as the condensation and rarefaction of the air particles conveying the sonorous vibrations which produced these vibrations.

The mechanical changes, or molecular vibrations in the wire, due directly or indirectly to telephonic currents, which result in the reproduction of sound, bear a close analogy to the mechanical changes due to the direct transmission of sound, but with this important difference, that while the vibrations due to sound are progressive along the wire, and their velocity is low and easily measured, those due to thermal effects are practically instantaneous, and therefore affect simultaneously the whole length of the wire.

Note.—De la Rive, in 1843 (*vide* "Electricity," vol. i., p. 304), observed that an iron wire emitted sounds when rapid discontinuous currents were passed through it, but he attributed the effect to magnetism, for he failed to obtain the same effect in non-magnetic wires like platinum or silver.

Graham Bell found, in 1874, that a simple helix without an iron core emitted sounds, and (in 1876) that very distinct sounds proceed from straight pieces of iron, steel, retort carbon, and plumbago when conveying currents.

Professor Hughes showed that his microphone was reversible, that is, that it could receive as well as transmit sonorous vibrations.

Mr. Weisendanger (*Telegraphic Journal*, Oct. 1, 1878) reproduced sounds on a microphonic receiver, which he called a thermophone, and attributed the effect to its true cause, viz., the expansion of bodies under the influence of heat, which, in fact, is the explanation of all microphone receivers.

Ader reproduced speech by the vibrations of a wire conveying currents of electricity, but he found that only magnetic metals were effective, and therefore, like De la Rive, he attributed the result to magnetic agencies. (*Vide* Count du Moncel, *Telegraphic Journal*, March 1, 1879.)

These and many other sonorous effects of currents on wires may be really due to such heat effects as I have described.

W. R. SYKES' DOUBLE ARM BLOCK INSTRUMENT.

AS USED ON THE MAIN LINE OF THE LONDON, CHATHAM AND DOVER RAILWAY.

FIG. 4 is a front view of a complete instrument for working both the up and down traffic, and is fixed at each end of a section. A (fig. 4) is a dial fitted with two arms, B and B.I., mounted behind a post, C; the arm, B.I., on the right hand side of C is worked by an insulated rod, D (figs. 1, 2, 3), connected to the reversing axle, E (figs. 1, 2, 3), the end of which passes to the outside of the case, and by means of knob F (figs. 1, 3, 4), can be turned to the right or left. On the other end of reversing axle, E, is fitted a cam, G (fig. 2), which works between two springs, H, H.I. (figs. 1, 2, 3).

The double stud, I, I.I. (figs. 1, 2, 3), is fixed between the springs, H, H.I., on the back of case, and on turning the knob, F, say to the right, the reversing axle, E, with the cam, G, turns also, cam G taking spring H.I. away from the pin of stud I, and allowing spring H to make contact with the pin of stud I. Cam G also makes contact with H.I.

Spring H is connected to the zinc of the battery; spring H.I. to the copper of the battery.

The turning of knob F, in addition to reversing the battery connections, also (by means of rod D) moves the arm, B.I., to a horizontal or "danger" position. By depressing the key or tapper, K (figs. 1, 2, 3, 4), which is connected to terminal 4 or Line, the latter, by means of the contact block, M (figs. 1, 2), is connected to reversing axle E and cam G, and thence to spring H.I. By the depression of the key also, the insulated back portion, *k*, of the key or tapper, K, raises a spring, N, which, together with terminal 6, is connected to terminal 1 or Earth, into contact with stud I, I (stud I being in contact with spring H), thereby sending the Copper current to Line and the Zinc to Earth.

By turning the knob F to the left, the arm, B.I., is lowered to "Clear," and the key being again depressed, the current is reversed, Zinc going to Line, and Copper to Earth.

The foregoing describes the arrangement for sending reverse currents, which is all mechanical. We will next consider the working of arm B, which is controlled by the instrument in the next section. Arm B is mounted on an axle having behind the dial a steel arm, O (fig. 2), kept magnetised by magnet P (figs. 1, 2, 3), working between two shoes, *n*, *s*, of the electro-magnet, Q (figs. 1, 2, 3). In giving "train on," by depressing key K, without moving knob F, arm B being at "clear," a current is sent to the electro-magnet of the instrument in the next section, which rings the bell there by attracting armature R (fig. 3), but does not alter position of arm B of that instrument. If the train is accepted, the knob, F (of instrument in next section), will be turned to the right, putting arm up to "danger," and the key depressed sending a current to line (which enters *viâ* 4, K, M.I. (fig. 2), to terminal 5 (fig. 2) into electro-magnet Q; from thence it passes through terminal 6 (fig. 2) to earth. This causes arm O to be moved from *n* to *s* (fig. 2), raising arm B to "danger."

When a "clear" signal is given, knob F will be turned to the left and arm lowered to "clear," the key depressed, and a reverse current sent into electro-magnet Q, which will bring arm B to "clear." It will be seen that the current passes direct from the battery without going through any coils or electro-magnets to line, thus saving a great portion of the ordinary gear put into block instruments.

In whatever position the arm of one instrument stands—Up or Down, Clear or Blocked—so the current is sent, putting the corresponding arm at the other end of the same position.

Fig. 1.

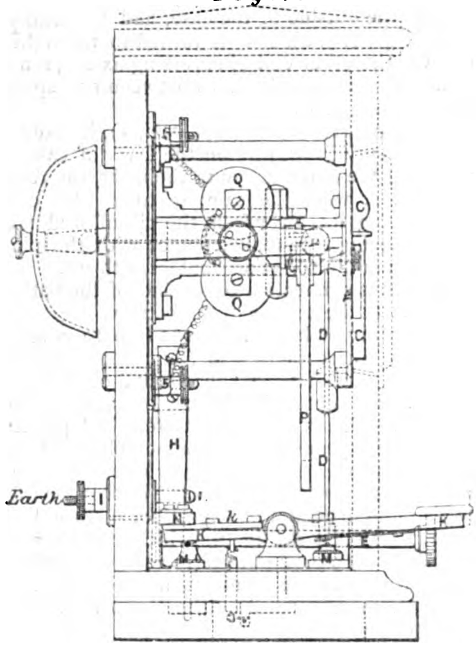


Fig. 2.

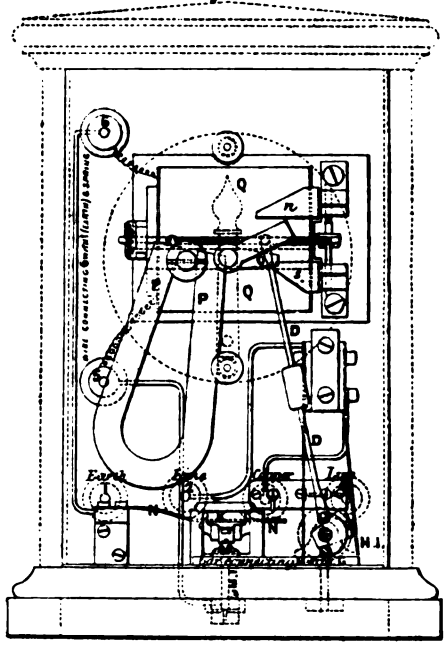


Fig. 3.

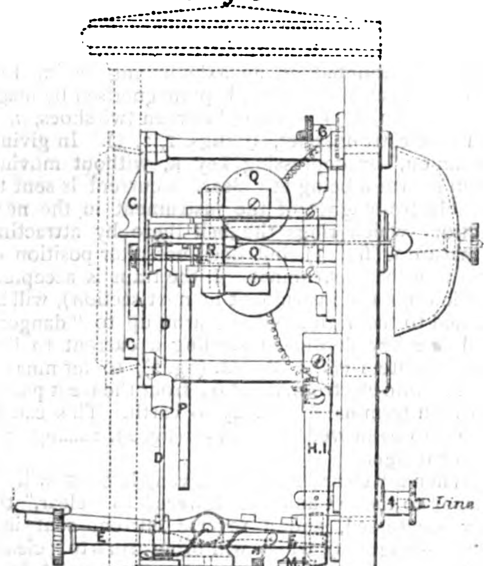
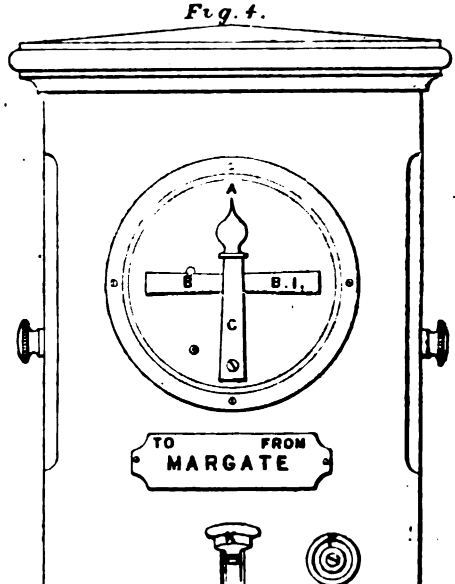


Fig. 4.



These instruments have been made partly from the old tapper bells by "Izant," and make a good and cheap block instrument with only *one* wire. The cost of each instrument is about £5 10s., and the old tapper bells can be altered at much less cost.

HUNNING'S MICRO-TELEPHONE TRANSMITTER.*

In its crude form the Hunning's Patent Micro-telephone Transmitter was in existence about three years ago, and has subsequently passed through a long series of modifications. Its present and most approved form was designed for the patentee by Mr. Cox-Walker, of York, to embody the various improvements suggested by experience. Its outward appearance is similar to that of the ordinary Bell telephone, but the resemblance stops there. The usual mouthpiece is covered on the under side of the opening by a piece of nickel-plated brass wire gauze, which forms a protection to a thin sheet of platinum foil. This foil acts the part of a vibrating diaphragm, and is in immediate contact with a very thin layer of granulated coke, which fills a small cavity provided with a brass plate at the bottom. The platinum foil is connected to one terminal through the brass ring, and the brass plate is connected to the other terminal. The terminal wires are then passed through the hole down the centre of the handle; the latter is screwed on to the central part, and the instrument is complete. In connecting it up for use, a receiving telephone (which may be Bell's or other similar instrument) is required at each end of the line in addition to the micro-telephone transmitter, and also a battery of Leclanché or other cells. The function of the transmitter is, by the aid of the battery current, so to increase the sound given out by the receiving telephone as to make these instruments a practical success, and also to overcome by its power the effects of induction from neighbouring wires, this latter having hitherto prevented the use of telephones on wires in the neighbourhood of others along which strong voltaic currents may be passing. The success of Hunning's Micro-telephone in this respect has been undoubted, and its clear articulation and power surprise all who hear it. The loose granulated coke between the two metallic plates is the secret of this success. When the platinum foil is spoken through at the mouthpiece, the aerial waves cause more or less of its under surface to come into contact with the grains of coke, at the same time causing these particles to press more closely upon each other, thus decreasing the amount of the resistance they offer to the passage of the voltaic current through them by bringing more points into contact with each other, this action taking place in a greater or less degree in accord with the amplitude of the vibrations of the platinum foil acting under the influence of the sonorous waves. The control which this movement of foil and coke grains exercises over the passing current is most perfect and wonderful, and it renders the use of an induction coil, which is found to be so great a necessity with all other forms of telephone transmitters—Edison's, Crossley's, and Blake's, to wit—quite unnecessary; and by the use of a special form of receiver, which is now engaging the attention of Messrs. Hunning and Cox-Walker, the effects of induction are hoped to be entirely eliminated, the experiments hitherto made by them in this direction giving promise of ultimate success. An automatic switch board, with call bell and ringing key, completes the outfit for each end of a line for telephonic purposes. The instruments were successfully tried a few weeks ago between York and Darlington, a distance of about 45 miles, the wire used for the purpose of this test trial being one of about 20 of the ordinary telegraph wires which stretch from pole to pole along the side of the railway. The effects of induction were at times most powerful, but they did not prevent the easy and successful carrying on of conversation or the transmission of ordinary railway cypher messages between the two stations.

* Abstract of Proceedings of the Cleveland Institution of Engineers.

VARLEY'S ELECTRIC TIME BALL.

There are few Londoners who do not recollect the time ball which formed such a prominent object on the top of the domed-shaped roof of the West Strand Telegraph Office. The apparatus, though an object of curiosity to our country cousins, and eagerly watched by an admiring crowd as the hour of 1 approached, ceased to exist after the transfer of the telegraphs of the United Kingdom into the hands of the State. Its removal, though no doubt lamented by some, has not been a great loss, as it can hardly be said to have been required in the locality where it was placed. Messrs. Dent, the well-known watch and clock makers, however, some time ago, made up for the removal by placing a time ball on the roof of their establishment in Trafalgar Square, which forms a conspicuous, if not handsome, object in that locality.

Several time balls are at present in use in our seaport towns, and prove of great value to the vessels which desire to set their chronometers to time. Mr. S. A. Varley has recently completed orders for time balls for India, and the apparatus invented by him is of the most improved pattern, and is thoroughly well designed for the purpose.

The design of a time ball apparatus at first sight may seem a very simple matter; a ball held at the top of a mast by a trigger, which trigger is released by an electro-magnet, when a time current is sent, would seem to be all that is required. The mechanism by which the object in view is to be accomplished is, however, by no means so simple as might be imagined. The weight of a ball six feet in diameter is not inconsiderable, and this dead weight of several hundredweights pressing on the trigger renders the latter very difficult of withdrawal, indeed, it cannot be released by the direct action of an electro-magnet. The apparatus, also, being usually set out of sight of the clock mechanism which releases it, requires to indicate whether it has acted correctly when the time current is sent out.

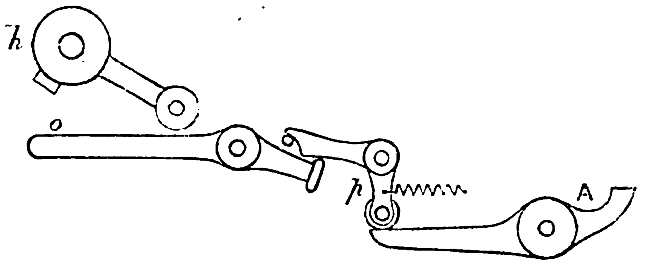


Fig. 1.

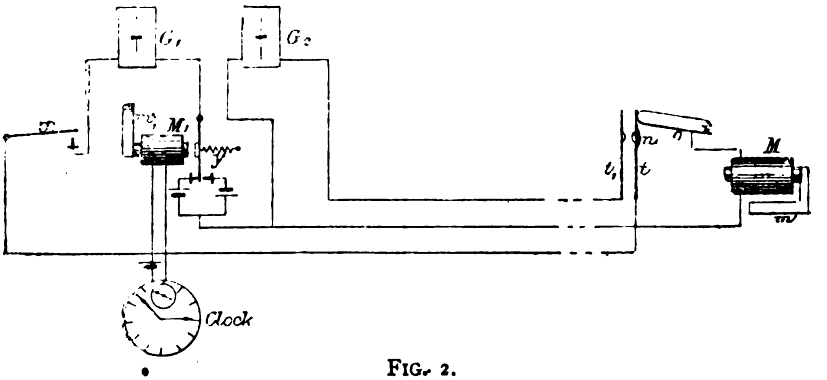


Fig. 2.

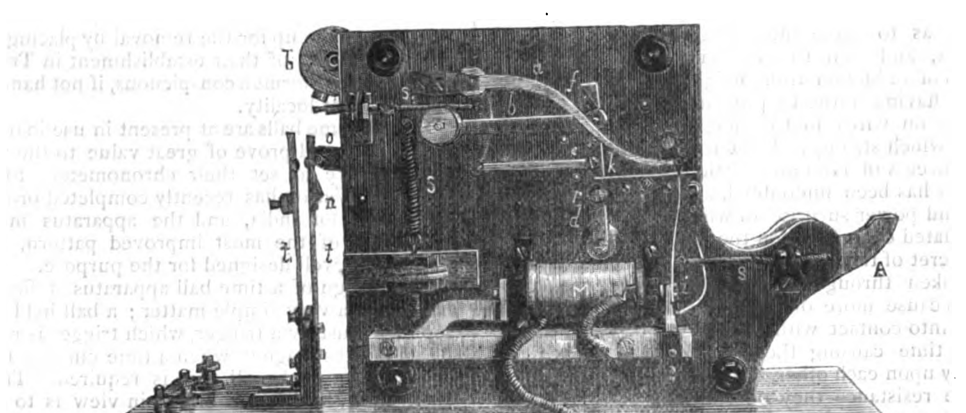


Fig. 3.

The apparatus which has recently been despatched to India by Mr. Varley consists of a hollow ball of zinc nearly six feet in diameter, this is attached to a piston rod with rack teeth cut in it, by means of which the ball can be raised with a winch to the top of the mast on which it slides. The piston at the end of the rod moves easily in a cylinder, and can drive out the air freely in front of it until it has fallen to within about a foot of its resting position, when it encounters the resistance of the cushion of air below it, which latter can only escape by a valve heavily weighted; when the ball is released, therefore, it falls quickly for the greater portion of its drop, and then gently for the last few inches, thus it is brought to rest without a jar or shock.

The trigger mechanism is shown by figs. 3 and 1, the latter indicating the parts hidden by the frame of the apparatus seen in fig. 3.

A is a strong lever with a hard steel face at A, upon which a projection from the piston rod rests, when the latter is in its highest position. This lever is of very strong make, with a stout steel axle, as it has to bear the full dead weight of the ball and piston rod. *p* is a second lever, bent, and with a steel friction wheel against which the longer end of the lever, A, rests; with *p* in the position shown, no amount of downward pressure on the curved end of A can cause the latter to fall. *o* is a third lever, by the depression of which *p* is moved, and the friction wheel slid off the lever, A. Finally, *h* is a hammer, which, on being released, strikes a heavy blow on *o*, which latter then actuates *p*, and by sliding off the friction wheel, allows the curved end of A to fall under the pressure of the piston rod and ball, and thus allow the latter to drop.

Referring now to fig. 3, *b* is a lever fixed to the same axis as the hammer, *h*; the weight of this lever is balanced and a pull given to the hammer to quicken the action of the latter, by means of the spring, S_1.

The vertical lever, *d*, has a piece, *f*, screwed to it, against the lower part of which a pin, screwed to the inner side of *b*, normally banks, thus preventing *b* from rising and *h* from falling.

a is a curved lever which is linked to *d*, so that when *a* falls, it pulls *d* to the right. The end of this lever has a small friction wheel.

g is a vertical lever, to which is fixed an armature, which is normally pulled by the core of the electro-magnet, M, this core being magnetised by the permanent steel magnet, *m*. On the top end of *g* the friction wheel at the end of *a* normally rests.

The action of the apparatus is then as follows:— Supposing the lever, *g*, to be drawn to the left, then the end of lever, *a*, is released, and it consequently drops under the action of the spring, S_2, *d* is then drawn to the right, and the pin on the end of *b* escapes from the piece, *f*, and thus *b* is released and *h* allowed to fall, when the actions on the pieces shown in fig. 3 occur in the manner previously described.

In setting the apparatus again, the hammer, *h*, is lifted up, this depresses the lever, *b*, and the pin of the latter pressing against the inclined side of the piece, *f*, pushes the lever, *d*, to the right; when the pin has cleared *f*, it then comes against the inclined piece, *c*, which is also screwed against *d*, this causes *b* to be moved to the left, and thus to lift the curved lever *a* so that the friction wheel at the end of the latter is raised until it again banks down upon the top of the armature lever, *g*.

The pieces seen in fig. 1 come back to their normal position when the hammer, *h*, is raised by the weight of the arm of A; thus the weight of the arm of A presses aside by its curved underside the arm of the lever, *p*, which has the friction wheel upon it, and then, on passing beyond it, allows the lever to drop to the position shown in the figure.

By means of the piece, *k*, which is moved by the pin, *r*, on the lever, *d*, the armature lever, *g*, is pushed over towards the electro-magnet cores when the hammer, *h*, is raised a little beyond its normal position.

The electrical arrangement by means of which the lever, *g* (fig. 3), is actuated, is shown in general principle by fig. 2.

M_1 is an electro-magnet whose cores are magnetised by a permanent magnet, m_1; the armature of this electro-magnet is normally pulled by the spring, *y*, away from the cores, but its tensile strength is not sufficient to overcome the magnetic pull unless the latter is decreased by a current sent by means of the clock.

The lever of the armature plays between two contacts connected to a "split" battery. *x* is a lever which is depressed when a handle is turned to "Time circuit closed," this handle, when turned half round towards this last position, pulls the armature of M over to the magnet cores, and then, on being turned the other half, leaves the same free, but the armature does not drop back again, as it remains attracted to the cores by the permanent magnetism of *m*.

The spring, *t* (fig. 3), is in contact, when the apparatus is set, with the end of lever, *o*, which latter is connected to one end of the wire of electro-magnet M through the frame of the instrument.

Supposing the ball to be wound up to the top of the mast, and held there by trigger A (figs. 1 and 3), then, a few minutes before the time current is given by the clock, the handle of the apparatus (fig. 2) is turned to "Time circuit closed," this depresses *x* against its stop, and moves the armature of M_1 against the cores of the latter, where it remains, held under the influence of the permanent magnet, *m*; a current from the left-hand battery consequently circulates through galvanometer, G_1, through the lever, *x*, and along the lower circuit to spring, *t*, and thence through the electro-magnet, M, back to the battery. By this current the needle of b_1 is deflected to "Time circuit closed," and the magnetism of M is *in*creased, so that the lever, *g*, is held more firmly on the locking position.

As soon as the exact hour arrives, the clock sends a current through M_1, decreasing the permanent magnetism in its cores, and releasing the armature, which consequently moves over to the right-hand stop under the influence of the spring, *y*. A reversal current is consequently sent by the right-hand battery, which deflects the needle of b_1, in the reverse direction, to "Current sent out;" this reversal current *de*creases the magnetism of M, and allows the lever, *g*, to be pulled to the left by the antagonistic spring, and to release the levers, and thus discharge the ball.

Now, immediately on the fall of the hammer, *h*,

the lever, *o*, being depressed, comes in contact with the ebonite projection, *n*, of the spring, *t*, and thus the current through M is cut off; but, at the same time, the spring, *t*, becomes pressed against the spring, *t*, and the current now flows through the galvanometer, G_2, deflecting it to "Ball discharged," thus indicating that the mechanism has acted properly. When this is seen to have taken place, the handle, before referred to, is turned to "Time circuit open," so as to cut the battery off, and it is left in this position until the time again arrives for the ball to be wound up.

The three wires shown in fig. 2 are only required between the time ball and the relay apparatus, in fact, are only local wires; the magnet, M_1, which sets off the mechanism, and which is worked by the observatory clock, of course only requires the usual single wire.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XI.

Direct Writer Duplex System—(*continued*).

It has been generally understood and explained that the principle of the Duplex telegraph system involves the production of an exact balance on the receiving portion of the transmitting instrument, so that when the key of the latter is worked no effect is produced; this is only partially true, that is to say, a balance, but not an exact balance, has to be obtained. To obtain an exact balance is impossible, as can be seen by reference to fig. 50, which represents the general principle of the Duplex system as worked by the Post Office. Referring to this figure, let us suppose the key at the "Up" station to be depressed, then in order that no effect may be produced on the electro-magnet, M_1, at that station, it would be necessary that the resistance, R_1, be equal to:—the resistance of the line, plus the balancing resistance, R_2, at the distant station (which resistance will be equal to R_1), plus the resistance of the two coils of the magnet, M_2. It is obviously impossible that this can be the case, consequently exact equilibrium can never be produced.

In what way then do the balancing resistances enable duplex working to be effected?

Now, although the balancing resistances cannot enable a neutral effect to be produced on the electro-magnet at any one station when the key at the latter is worked, still it can enable a comparatively small effect to be produced on the same, an effect due to the difference in the strengths of the currents passing respectively in opposite directions through the two coils of the electro-magnet, and which can be counteracted by the tension of the armature spring.

But, it may be asked, what values should the balancing resistances have? The answer to this is—the adjustment must be such, that when signals are sent from the distant station, the strengths of these signals must not be altered, on alternately depressing and raising the key at the home station. The values of the balancing resistances necessary to produce this result are of course found by trial, their theoretical value it is unnecessary to determine.

Supposing the required balance to be obtained, then the action of the apparatus will be as follows:—Supposing the key, K_1, at the "Up" station to be depressed, the one, K_2, at the "Down" station being in its normal position, then the current from the battery, E_1, will split, half going through the resistance, R_1, and the coil of M_1, represented by the . . . . . . line; the other half will go out to Line to the "Down" station and through the balancing resistance, R_2, from thence it will pass through the . . . . . coil of M_2 and back through the coil represented by the ——— line, to Earth, from there it will pass back to the Earth at the "Up" station, and through the ——— coil back to the battery. It will be noticed that the current passing through the two coils at the "Down" station does so in opposite directions, and as the coils are wound in *opposite* directions the full magnetic effect due to the two is produced, consequently the instrument responds. The currents passing through the coils at the "Up" station do so in the *same* directions, consequently a small magnetic effect only is produced, due to the two currents being of unequal strength. This small effect, as was explained, is counteracted by the tension of the armature spring.

If the "Down" station depresses his key whilst the "Up" station key is left in its normal position, then the instrument at the "Up" station of course responds.

Lastly, supposing both keys to be depressed, then since the two batteries have their opposite poles in connection with one another through the line, and through the ——— coils of the electro-magnets at the two stations, these batteries will send a strong current through the coils; also each battery will send a current through the balancing resistances and through the . . . . . . coils, but the strength of the currents going through the ——— coils will be about double that going through the . . . . . . coils, consequently both electro-magnets must respond.

In adjusting the balancing resistances or rheostats the telegraphist at, say, the "Up" station sends signals on his key to the "Down" station, and the latter adjusts his rheostat until he finds that his received signals do not alter in strength when he keeps his own key alternately depressed and raised. If there is too much resistance in the rheostat the received signals will be strong when the home key is at rest, and weak when it is depressed. The telegraphist is thus able to judge whether he must increase or decrease the resistance in the rheostat. When it is found that the signals are uniform the received signals are stopped, and the home station works his key, and increases the tension of his armature spring until his own signals cease to affect his apparatus. A similar operation is then gone through by the distant station.

Now, it must be obvious that when the Down station adjusts his rheostat, after the Up station has obtained his required balance, the latter must be thrown out again. This is true to a certain extent, but the amount by which it may throw the balance out is comparatively small. That is to say, for example, one hundred ohms wrong in the home rheostat would affect the home instrument more than would two or three hundred ohms wrong in the distant rheostat. If this were not the case the balancing would give a great deal more trouble than it actually does.

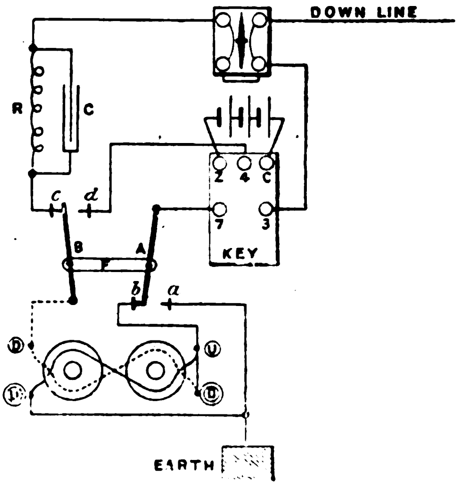


FIG. 51.

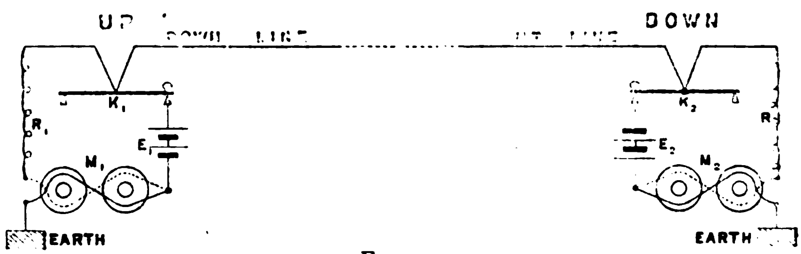


FIG. 50.

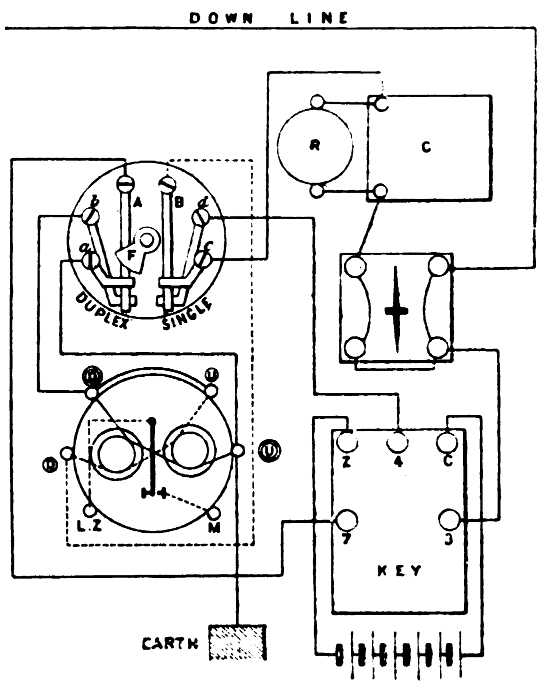


FIG. 52.

Of course at starting, more trouble is caused in the balancing than after a time, since the operators soon get to know the approximate required values of the resistances, and it is only comparatively small variations of these from time to time that are necessary to keep the adjustments correct.

Double Current Duplex System.

This system is employed on lines beyond the range of single current working. It is worked by means of relays, and the key, instead of making and breaking contact, as in the single current duplex, sends reversals.

The principle of the system can be seen from fig. 51, and the general arrangement for an "Up" station from fig. 52. The connections, it will be noticed, are very similar to the direct writer duplex indicated by fig. 48 in the last article, what difference there is being in the key and in the galvanometer. The latter is provided with two differentially wound coils accurately adjusted. Formerly no great care was taken to obtain good adjustment in the winding, but recently this has been more carefully attended to, and with very beneficial results.

When arranged for duplex working the switch of the key is kept turned to "send," so that 4 and 3 are disconnected, and the battery is in communication with 7 and 3, Zinc being to 7 and Copper to 3 when the key is at rest, and the reverse when it is depressed.

At the "Down" station the line connections are similar to those at the "Up" station, but the battery is reversed.

The action of the double current duplex is as follows:—Supposing the two keys to be at rest, then the conditions are similar to those in the single current duplex when the keys at both stations are depressed; that is to say, strong currents traverse the ——— coils and weak currents the . . . . . . coils; but the effect on the electro-magnets of the relays is such as to press the tongues over against the insulated contact on the "spacing" side.

If now the "Up" station key be depressed, then the current from that key becomes reversed, and as similar poles of the batteries are to line, no current flows through the latter or through the ——— coils, but currents from each battery traverse the . . . . . . coils of their respective electro-magnets. Now at the "Up" station the direction of the current through the . . . . . . coil will be in the reverse direction to what it was at first; in other words, it will have the same effect on the electro-magnet as had the stronger current that was passing through the ——— coil before the key was depressed, consequently the tongue of the relay will still remain pressed over to the spacing side. At the "Down" station, however, the current through the . . . . . . coil will not have been changed in direction, and as this is not now opposed by the strong current through the ——— coil, its effect will be to move the tongue of the relay over to the "marking" side, and to produce a signal.

A similar action to the foregoing obviously takes place when the key at the "Down" station is depressed, that at the "Up" station being in its normal position; in this case the tongue of the "Up" station relay will respond.

When both keys are depressed, the action is the exact reverse of what it was when both keys were at rest, consequently both tongues must be moved over to the "marking" side.

On short circuits, such as are worked by the Direct Writer Duplex, no inconvenience is felt from the static charge or discharge which takes place when the keys of the instruments are worked, but on long circuits the existence of the disturbance cannot be ignored; condensers have therefore to be introduced in connection with the balancing resistances so as to enable the effect of the discharge to be counteracted. The adjustment of the necessary condenser power is made after the balancing resistances have been adjusted. As has been explained, the resistance adjustment is made by causing the distant station to send signals, and then observing whether the strength of the latter is altered when the home station key is alternately held down and raised up. This adjustment once obtained, the home station key is worked quickly, and then the condenser power adjusted until the "kicks" on the instrument are got rid of; the distant station then does the same.

Errata.—Page 191, 11th line on second column, should read "caused by a line or an instrument fault, terminal 4."

Page 192, 8th line on first column, should read "terminals 7 and 4, then the receiving instrument should respond."

Page 194, 5th line on first column, should read "the lever A and both coils of the electro-magnet."

ELECTRICITY AS A MOTIVE POWER.

The following letter, concerning certain experiments on the application of electricity as a motive power, appeared in a late number of the *Times*:—

"About this time last year I sent you a short account of some experiments by Mr. C. Felix, of Sermaize (Marne). This gentleman has continued his experiments, and at the Regional Agricultural Show now being held in this town, his apparatus has been shown at work. It consists of the ordinary 'Gramme' machine, worked by a semi-portable engine, furnished by Boulet and Co., Faubourg Poissonnière, Paris. Two coils of wire convey the power to a smaller Gramme fixed on a framework of wood, movable on four wheels. This acts as an intermediate motion, and has two broad-face pulleys, one on each side, 20-inch and 14-inch diameter; these run at a speed, if required, of 800 a minute, the latter driving a 6 horse-power thrashing machine at a considerable distance from the main power. The 20-inch pulley might be used for driving any other machine if required.

"The ploughing apparatus, which is at work at the same time, in the field adjoining, consists of a similar Gramme machine, fixed in a very solid framework of wrought iron, about 6ft. long by 5ft. wide, standing on wheels, 3ft. 6in. diameter, in front, and 4ft. 6in. behind. Shafts and a locking gear are also attached. There are two of these at work for ploughing, as in Fowler's double tackle.

"The Gramme has two pulleys, as I before stated,

one on each side. These, by friction rollers, work the drum of the ploughing tackle, round which the steel wire rope is coiled, the drum being in the centre of the carriage, the wire escaping from the lower part near the ground, and guided in its course by two flat rollers.

"The plough is one of Howard's double-furrow, supplied by Mr. Pilter, Paris, and fitted for the purpose.

"The power is conveyed in an instant from the main power in the showyard by a coil of wire on wooden reels, long enough to reach several fields off.

"The plough worked clean and regularly about seven or eight inches deep. The ground was very hard and uneven, as this part of France is suffering very much from want of rain. One man is required to each machine, and one man to the plough, three in all. The ploughing was not very straight, for, as the people crowded about the plough and on the ropes, the driver could not see where he was going. Directly the plough reached the end of its course, it was lowered and returned, the machine being thrown out of gear and reversed with the greatest ease.

"The machines are also advanced or retired without the least difficulty. When this is done, the friction rollers are detached, and the power conveyed to a chain and notched wheel, which move the machine rapidly forward as the ploughing work progresses.

"The manager, Mr. Ducret, states it would be just as easy to work a three or four furrow plough as this double, but the holdings being small in this country it is not necessary.

"Mr. Felix, who is here superintending his invention, has a large sugar factory at Sermaize, and there may be seen his various machines worked by electricity, as we indeed see in this showyard.

"The officials connected with the show and many others were present, and the greatest interest was manifested in the trials. Electricity as a motive power is only in its infancy, but who can help feeling sanguine as to its future?

"J. S. COCKSEDGE, of Stowmarket.

"Bar-le-Duc, France, May 22."

THE JAMIN ELECTRIC LIGHT.

ON Friday, June 4th, some trials of the Jamin Electric Light were made in the laboratory of the Compagnie Générale d'Eclairage Electrique, 57, Avenue du Maine. A large concourse of scientific notabilities was present, including M. Gambetta, M. Durrieu, the Minister of Public Instruction, Messieurs Dumas, Perpetual Secretary of the Academy of Sciences; Vaucorbeil, Bréguet, Renier, Hervé-Mangou, Director of the Conservatoire des Arts et Métiers; Antonin Proust; Admiral Moucher, Director of the Observatory; Desain, Professor of Physic at the Sorbonne; Frémy, Director of the Museum; Daubrée, Director of the School of Mines; Hébrard, senator, Director of the *Temps*; Gailly, senator; Delpech, Martial Bernard, Vauthier, Engelhard, Cernesson, of the Municipal Council, &c., &c.

The Halle Electrique, where the experiments were held, is one hundred feet long and seventy feet wide. At the entrance six large opal globes were placed, and on the right and left a row of the Jamin lamps. The Gramme machines were placed at the further end of the room.

After a brief description of his new lamp, M. Jamin performed a series of experiments which showed the capabilities of the apparatus.

By an automatic arrangement the lighting and relighting of the lamps are instantaneous. This result is obtained, without touching the apparatus, by simply establishing or re-establishing the communication.

Should one of the lamps become accidentally extinguished the other lamps continue to burn as usual, and the intensity of their lights is by no means affected by it. Moreover, should one of the candles become consumed, another is instantly and automatically brought into play.

The light may be graduated or regulated at will, from its full power down to the light of a night light.

The light is well divided and can be conveyed at a distance nearly indefinite; for, in the experiments, it has been conveyed to a distance of two miles and a half by a copper wire one millimetre in diameter, and to a distance of ten miles with a wire two millimetres in diameter.

The fixity of the luminous rays was very great, and they were entirely free from violet or red tints.

The *soirée* was wound up by the general illumination of the hall, which was obtained, it is stated, by twenty *indicated* horse-power and forty lights, the illuminating power of which was equivalent to 2,000 Carcel lamps.

The company formed to work M. Jamin's system has a capital of £320,000, all of which has been subscribed. The new company will be possessed of the largest capital which has until now been engaged in the working of electric lighting business, and it can besides reckon on the active concurrence of the Crédit Industriel, one of the largest, oldest, and most favourably known banking establishments of France, and under the patronage of which the new company has been formed.

A very remarkable feature of the new company is, that instead of having been formed as it has up to now been the case, in opposition to the gas companies, and with a view of causing a depreciation of their stock, it has on the contrary been formed with the sympathetic concurrence of personages well known in connection with the industry of gas.

One of its founders, Mr. Gabriel Dehaynin, is one of the most influential, best known, and most largely interested persons in gas property in France. He is the proprietor of more than 60 gas works, and the inventor of a very remarkable process for the manufacture of gas.

THERE is no truth in the statement that the Post Office has come to an agreement with the telephone companies. The suit, it is expected, wiil shortly be tried.

Notes.

Electricity on Board Ship.—A steamer named the *Columbia*, which has just been completed at Chester, Pennsylvania, for the Oregon Railway and Navigation Company, has several novel and interesting appointments. Thus, the Edison electric light is adopted throughout the ship. We learn from the *Scientific American* that the lamps are 120 in number. The lights of the state-rooms are under control of the steward on the out-side. The state rooms on the upper and lower decks are on separate circuits, and so are the saloons. The lamp-fixtures are of the same form as those used for oil lamps, and by an ingenious contrivance they are adapted to either the electric or oil lamp, so that should the former fail in any way, the latter may be at once substituted. The electric lamp globes are frosted lightly by dipping in hydrofluoric acid. The desirability of electric lighting on shipboard, where the apartments are necessarily small, is obvious. The *Columbia* has further an electric head light, consisting of a Maxim electric light. All the rooms are fitted up with electric calls, and the offices, smoking-room, &c., are provided with telephones, the smoking-room being in connection with the steward's room, and the captain's with the chief engineer's, purser's and steward. An electric tell-tale on the bridge enables the captain to tell, by simply pressing a button, whether the engine is going ahead or back, and at what speed. The steering gear has connection with the freight-hoister, but with self-acting attachment. The elevators for discharging cargo are new in design, and the running engines at the ports are arranged so that a loaded truck runs from the lower hold out to the dock entirely by steam. The arrangement of berths is similar to that in a Pullman palace car, and when the berths are not in use they are folded out of the way. The system of water-supply for fire, &c., is most complete; and a new kind of still is used which is capable of supplying 1,200 gallons of pure fresh water daily. The *Columbia* is 334ft. length, 38½ft. beam, 23ft. depth of hold, and 3,200 tons measurement.

The printing offices of the *Neue Freie Presse* at Vienna are now lighted with Siemens' divided electric lamps.

Curious Magnetic Experiment in Magnetism.—M. Obalski has described a curious magnetic experiment to the French Academy. Two magnetic needles are suspended over water in a vessel by fine threads attached to unlike poles. Their poles are opposite, and are distant from each other by an amount a little greater than the sum of their radii of mutual attraction. The water is gradually brought up over them by means of the tube of caoutchouc connected with the vessel and wound on a drum. When immersion commences, the needles approach each other by their immersed parts, and when the immersion has reached the third or fourth of the needles' length, they touch together. The explanation seems to be, that what hindered the approximation of the needles was their own weight; and the force of gravity being weakened by the immersion, the magnetic forces become manifest. If the needles are suspended by their poles of the same name, a corresponding though opposite phenomenon is witnessed.

Professor Cohn finds that bacteria in a nutritive mineral solution subjected to strong electric currents, become sterilised. Five elements were sufficient in twenty-four hours to effect the result; the action was strongest at the positive pole.

A suit has been brought in the Circuit Court at Madison, Wisconsin, America, to collect from an insurance company for damages done by the great storm of 1878. The property was insured against lightning, and the company resist payment on the ground that it was destroyed by wind. The plaintiff hopes to prove by the evidence of members of the Signal Corps that the whirlwind which destroyed his house was of electrical origin. A vast amount of insurance is likely to be affected by the decision of this case, owing to the heavy losses of property during the recent whirlwinds.

General evidence of the electrical character of all tornadoes is found by Prof. Tice in the circumstance that, as a rule, they follow railroads and water courses, and either begin or expend their greatest energy upon them.

The telephone is now in use for reporting between the House of Commons and the *Times* office. The compositor announces by the bell that he is ready, receives a sentence, strikes the bell to indicate that he understands it, sets up the type with his machine, strikes the bell again for the reader to continue his dictation, and so on until the work is carried as far as time will allow.

Improvement in Telegraph Keys.—A patent has been issued to Mr. Walter P. Phillips, manager of the New York Associated Press Bureau, at Washington, and of the telegraph line leased by the Associated Press between New York and Washington, for an improvement in telegraph keys. This improvement consists in substituting hardened steel for platinum for the contact points, making the lower contact point large and flat. These lower contact points, or "anvils," fit into a socket, and can be changed whenever necessary, the idea being to supply them by the box, for renewal, when necessary, at a very small price, say two or three cents each. The key is much simplified and its cost greatly reduced. It is stated that the keys have been in constant use for two or three months on the Associated Press wires, and have been tested at the United States signal office and elsewhere, and have given general satisfaction. One of the principal advantages claimed for these keys is that it is impossible to make them "stick."—*Journal of the Telegraph.*

New Instances of Magnetic Attraction.—By M. Ader, in *Comptes Rendus*, 1880, p. 864. When making his researches on magnetic quality of wood, paper, and other light bodies, the author made pith balls 5 mm. in diameter, and found that the permanent magnet of Jamin (which supports 100 kilos.), with two small armatures, having a space between of 2 mm., attracted the suspended pith from a distance of 3 or 4 mm. And when once the ball had adhered to it, only rough shaking of the magnet was sufficient to release the ball from its position. The magnet alone sufficed to attract the pith, but in all experiments attraction was much stronger when to the poles of the magnet were added the said soft iron armatures, in close proximity to one another.

M. D. Lachinoff has constructed a regulator for use with dynamo machines. Any variation of strength of the current in the circuit opens more or less the steam valve of the engine, thus increasing or reducing the speed of the steam engine, and consequently of the dynamo machine.

The Western Union Telegraph Company has secured the services of Mr. George d'Infreville, the well-known telegraph engineer.

A BILL to establish a Government postal telegraph service has been introduced in the House of Representatives, America. It directs the Postmaster-General, for the purpose of testing the policy and practicability of maintaining a general system of a postal telegraph line, and of affording to the people of the United States the benefit of a cheap telegraphic communication, to establish by purchase or construction a telegraph line or lines between the cities of Boston and Washington by way of Springfield, Hartford, New Haven, New York, Jersey City, New Brunswick, Philadelphia, Chester, Wilmington, and Baltimore. It provides further that the rates for transmission of telegraphic messages shall be as follows:—For 25 words or less, for a distance of 200 miles or less, 15 cents, with ½ cent for each additional word. For a distance of 500 miles or less, 25 cents, with one cent for each additional word. For 1,000 miles or less, 40 cents, with 2 cents for each additional word. For 2,000 miles or less, 75 cents, with 3 cents for each additional word. For 3,000 miles or less, 1 dol., with 5 cents for each additional word. For less than 200 words, when the messages pass between two adjoining offices, 10 cents for each message, with ½ cent for each additional word. The Postmaster-General is also authorised, without further legislation, to extend the postal telegraph lines between New York, St. Louis, Chicago, and New Orleans, and such other cities and postal stations as he may see fit, provided that the system herein established shall be found to be advantageous and beneficial, and an appropriation of 300,000 dols. is made for the purpose of enabling him to carry out the provisions of this act.

MR. HALL recently in the *Philosophical Magazine* (No. 9, 1880, p. 225), detailed the following experiment:—A very fine leaf of gold, 2 centimetres by 9 centimetres, attached face to face on a glass plate, was placed between the poles of an electro-magnet, the gold leaf being introduced in an electrical circuit, two electrodes from a very sensitive Thomson mirror galvanometer touching the leaf in two places of equal potential, so that the spot remained at zero. If then a strong current was passed through the electro-magnet, immediately the galvanometer showed a difference of distribution of potentials in the leaf.

TELEGRAPH WIRES IN THE CITY.—The countless number of wires that run through the streets on poles and over the top of almost every building in the lower part of the city, is the subject of general and constant attraction from passers-by, and any one with an inquiring turn of mind naturally asks: "I wonder how many miles of wire there are in New York City?" This question has always been an unanswerable conundrum until recently, when inquiry was made at the principal offices of the different companies for the purpose of ascertaining the exact number of miles of wire owned by each, with the following result:—Western Union, 1,109 miles; Gold and Stock, 1,380 miles; Bell Telephone, 800; American District, 450; Atlantic and Pacific, 310; American Union, 250; Law Telegraph Co., 110; Police and Fire Alarm, 100; American Rapid, 88, and Department of Charities and Correction, 20, making a total of 5,567 miles. Besides this number, which represents the number of miles of wire in actual use, there are about 500 miles of "Wild-cat" lines, which are lines put up surreptitiously on the poles of the different companies, and old wires that are no longer used but still remains on the poles. Thus the actual number of miles of wire, in round numbers, is 6,000 miles—enough, if stretched in a single line, to run from New York to the Mediterranean and back. The number of miles of poles owned by the different companies was also ascertained. The Western Union has 53 miles (also used by the Gold and Stock Company), the American Union about 50 miles, and the Fire Alarm 10. The Telephone and the American District Companies generally run their wires over the tops of houses. It is evident to the most casual observer that telegraph wires in this city must eventually be laid underground. With this end in view the Western Union Company have been conducting experiments for some time past. Sixty wires have for some time been laid underground from the Western Union building to to the Courtland Street Ferry, where they connect with the Hudson River cables, and twenty-eight more have recently been laid to 14, Broad Street, which is the most important branch office of the Western Union Company. All of these wires work as well as the aerial lines, and have given much satisfaction; and as the above-named experiments have yielded very satisfactory results, there is no doubt that all of the Western Union wires in this city will be laid underground in the near future. It is only a question of a little time now. When the unsightly poles are removed from the streets and the wires taken off of house-tops, New York will have good cause to rejoice.—*The Magnet.*

THE statement that the Government has purchased Brush lighting apparatus to the extent of several thousand pounds, is untrue. One machine and sixteen lamps have been ordered for trial.

PROFESSOR FLEEMING JENKIN has been awarded the Keith prize by the Royal Society of Edinburgh, for his paper on "The application of graphic methods to the determination of the efficiency of machinery."

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—I enclose herewith the last three tests of the subterranean cable laid by me last September at Bruges, taken by M. Dumont, the engineer of the Belgian Administration. It will be observed that M. Dumont makes the electro-static capacity about one-tenth that made by Mr. Aylmer of the Versailles cable. The two cables are similar, each having 22 conductors. Mr. Aylmer, when he tested one conductor for electro-static capacity, had the 21 other conductors connected to earth, whilst when M. Dumont made his tests all the other conductors of the group were disconnected from earth.

Very truly yours,

Brussels, May 30, 1880. D. BROOKS.

Insulation Tests of Brooks' Cable.

TEMPERATURE.	DATE OF TEST.	RESISTANCE PER KILOMETRE. MEGOHMS.
10° C. ...	April 28th, 1880 ...	904.5
24° C. ...	May 14th, „ ...	290
14° & 17° C.	May 25th, „ ...	276

Electro-static capacity of the Cable.

TEMPERATURE.	DATE OF TEST.	CAPACITY PER KILOMETRE. MICROFARADS.
10° C. ...	April 28th, 1880 ...	0,013
24° C. ...	May 14th, „ ...	0,011
14° & 17° ...	May 25th, „ ...	0,015

These tests were made on the cable laid at Bruges.

J. DUMONT,

Brussels, May 29th, 1880. Engineer.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

(Continued from page 199.)

In 1879 the mileage of Post Office wires used for commercial traffic, existing on railways was	54,067 miles.
Existing on roads and canals . . .	46,784 „
Existing in the local submarine cables .	1,805 „
	102,656

In 1869 the number of instruments fixed upon commercial wires, and used to work them, was as nearly as can be ascertained about 2,200.

In 1879 the number was, of various kinds, 8,151.

It must also be stated that the increase in the rapidity of the instruments employed, *i.e.*, their average power of transmitting messages, is far greater than that of their numbers.

In 1869 there were, for example, two Wheatstone automatic circuits existing in Great Britain—one London to Manchester, one London to Glasgow—worked of course by four instruments.

In 1879 there were 173 such instruments employed.

In 1869 no duplex instruments existed.

In 1879 there were 392 employed.

This means, in effect, that wires formerly worked by ordinary instruments had been practically doubled in numbers by the adoption of the duplex system.

In 1869 quadruplex of course had not been thought of.

In 1879 there were six circuits worked by that invention, making the six wires equal to twenty-four in carrying capacity.

In 1869 no sounder instruments were employed.

In 1879 there were 1,374 of these instruments in use, the result being that an equal number of Morse printers were dispensed with.

It has often been stated that the Government monopoly of commercial telegraphs has stifled invention. Such statements are wholly without foundation. No invention promising either superior results to those previously attained, or promising to effect equal results with greater economy, or other distinct advantages, will ever be otherwise than welcome to the Department.

Where an alteration would have the effect of throwing out of use a large stock of apparatus, in which a very large capital had been embarked, it is clear that such alteration must be of very decided advantage: a trifling gain over existing means would not be sufficient to justify the commercial waste, so to speak, that must arise from its adoption. But if there is a great advantage, even this loss would be submitted to, rather than that the invention should be ignored. No doubt, in one respect, inventors do not find the market quite so open to them as formerly. When it was possible for several commercial companies to struggle against each other, it was always possible for the inventor of a novelty (although such novelty might be in no essential particular really superior to what was previously existing) to get the assistance of a promoter to form a company to work it. Thus, when the Electric Telegraph Company were depending chiefly on Cooke and Wheatstone's needle instrument, one of their first rivals was started to work Henley's magnetic needle telegraph, although most certainly, so far as the public were concerned, the working of this apparatus gave them no advantage, whatever the creation of an opponent company might do. In fact, not long after, the company owning it employed other instruments.

In this respect, do doubt, the Monopoly Act has closed one field of speculation; but the Post Office cannot be blamed for an unavoidable effect, and perhaps not altogether an undesirable one.

But wherever good has been found it has been availed of. The inventive genius of our Transatlantic cousins has had a fair field of action in our borders, and its worth has been fully and practically acknowledged.

As an illustration of the steady, though not show progress that the Post Office has made in the improvement of its apparatus—a degree of improvement really far more valuable than the introduction of ordinary inventions—it may be stated that, when Sir Charles Wheatstone brought his automatic instrument to the Electric Telegraph Company in 1866, it was only possible to work it at the rate of about 55 to 60 words a minute if a wire of No. 8 gauge was employed, increasing to 80 words a minute if a wire of No. 4 gauge were used; this over a circuit about 280 miles in length.

In 1879 it was possible to work for distances of 300 miles with No. 8 gauge wire at over 200 words a minute, and regularly and in all weathers at 130 words, and this with 70 miles of cable in circuit.

These improvements have been brought about almost wholly by the officers of the Department and of the former telegraph company, and by the skill of the mechanics acting with them.

In 1869 the length of internal submarine cables was about 121 knots, the total being made up of 18 separate cables.

In 1879 this total had grown to 614 knots, including 58 separate cables, containing from one to seven conducting wires respectively.

Three miles of pneumatic tubes were in use in 1869.

In 1879 there were in existence over 27 miles.

In 1869 the number of towns supplied with intelligence by electric telegraph in this country was 144, and in them news was furnished to 173 newspapers and 133 other subscribers.

In 1879 the number had increased to 313 towns, 518 newspapers, and 288 institutions or individuals supplied.

And the number of words transmitted—which in the days of the telegraph companies was a varying daily average of from 4,000 in the non-parliamentary season to 6,000 when the Houses were sitting—has grown until, in 1879, it reached 24,000 and 37,000 words in the corresponding seasons. This news is despatched by the two great Press agencies to the towns enumerated previously, the actual words transmitted over the wires to the various places often exceeding half-a-million, the same words having to be repeated to many places.

Besides this, from 30,000 to 70,000 words per diem, according to the season, are despatched as special reports for various London and provincial newspapers, from their own correspondents, being wholly additional to the general news supply.

There are certain newspapers to whose use special wires are devoted, *i.e.*, instead of receiving intelligence transmitted over the ordinary wires in the ordinary way, they have arranged to have certain wires given up for their sole use from 6.0 p.m. to 6.0. a.m., or other hour, and send over them whatever matter they like without its being counted as business done by the Post Office, clerks being lent to them for the purpose.

The Electric Telegraph Company, prior to the transfer, had inaugurated this system.

In 1869 there were a total of 6 special renters, each paying from £750 to £1,000 per annum for the wire appropriated to them. In 1879 there were 24 such renters, each paying £500.

The private telegraphs amounted to 2,525 miles of wire, worked by 1,466 instruments, in 1869.

On the 31st December, 1879, the Post Office maintained for the use of private persons 6,550 miles of wire and 3,824 instruments, or, including wires used by railways in Ireland for their own purposes, and by certain canal companies, which are maintained also by the Post Office staff, the total is 9,269 miles of wires and 4,607 instruments.

The Post Office possesses no monopoly of private wires, and in calculating the whole existing telegraphs of the country, a large addition must be made to represent the wires and instruments fixed in various localities by private contractors, not forgetting the recent active operations of the various telephone companies.

So far as it can be ascertained, the gross earnings of all English telegraphs in 1869 may be stated with certainty as not more than £700,000.

In 1879 the earnings of the Post Office Telegraphs were on the whole £1,436,000—a sum more than double the amount of the largest earnings of the telegraph companies. Moreover, ten years after the transfer of the lines to the State had been effected, the balance-sheet of the Department shows that the telegraphs have become practically remunerative, *i.e.*, that for the financial year ending 31st March, 1880, there is for the first time almost an equilibrium between receipts and expenditure, including in expenditure the full interest on the capital borrowed for the purpose of purchasing and extending the telegraph undertakings, and the total capital cost of all extensions during the year for which the receipts are stated; from which latter are excluded the value of services performed for other Government Departments, and value of materials, &c., sold, amounting on the whole to £36,000. To be exact, in the year 1878-79 the sum required from the national coffers to make up the actual interest on capital was over £114,000; for the year 1879-80 the precise calculations are not made; but although the amount of capital on which interest has to be paid is increased by a sum absorbing over £4,000 per annum, the deficiency will pretty certainly be not above £30,000. It is probable that, if the accounts were compiled on the system that would be adopted by a commercial company, this deficiency would be converted into a surplus of an equivalent sum.

In 1869 the working of the various telegraph undertakings, other than those of railway companies, employed a total force of 2,514 clerks, 479 of whom were females, and 1,471 messengers.

In 1879 the clerks numbered 5,611, of whom 1,556 were females, and 4,648 messengers.

For the financial year ending 31st March, 1873, the number of telegrams forwarded throughout the United Kingdom was 15,535,000; it was for the year ending 31st March, 1880, over 26,500,000, being an addition of nearly three-fourths in seven years.

The first year taken for this comparison is the one named (1873) because otherwise due allowance would not be made for the immediate expansion of business which arose after January, 1870, in consequence of the large increase in the number of offices, and of the operation of the uniform shilling rate.

In 1878 the population of Great Britain and Ireland was reckoned at 33,799,000, and this population exchanged a total of 24,600,000 messages.

In France the population of 36,900,000, employed the telegraph to the number of 14,400,000 messages, or upwards of 10,000,000 less than the number passed over the wires of this country.

In Germany, with a population of 42,700,000, the number of telegraphic despatches was barely 100,000 more than those of France, or 14,540,000.

The only cases in which the proportionate number of messages is at all larger than in Great Britain are those of Belgium and Switzerland.

In neither of these States does the total number of messages amount to 1 per head of the population, and in Belgium the number forwarded is even closer to the British ratio as compared with population. But both these countries derive an exceptional advantage from the number of foreign telegrams passing through them, and not, as it were, resting within their borders. English messages are not swollen to any appreciable extent from this cause. Switzerland, moreover, has its native business largely increased by the host of locomotive and telegraphing foreigners annually attracted to the playground of Europe. Hence it may be fairly said that England is decidedly ahead of continental Europe in the matter of telegraphic employment.

During the present year arrangements have been made for the erection of over 5,000 miles of new wire, intended to meet the demands upon the system made by the prospect of reviving trade. The cost will not add to capital sunk in telegraphs, but will be all charged to the revenue of the Department.

For two or three years past, owing to the commercial stagnation that has prevailed, the rate at which the use of the telegraph has progressed has been but slight.

As regards railway telegraphs there are at present 14,889 miles of poles, 62,099 miles of wires, 13,128 speaking instruments, 22,411 block instruments, and 11,308 semaphore repeaters. All these being used for working the "block" system.

In the discussion which followed the reading of the paper

SIR CHARLES BRIGHT, late chief engineer to the British and Irish Magnetic Telegraph Company, said that he considered that the progress that had been made in telegraphy under Government management was highly creditable. As regards Sounders, he pointed out that his Bell system was entirely one of sound, and was exclusively used by the company of which he was engineer. He hoped that at some future date statistics of foreign messages would be forthcoming.

MAJOR WEBBER pointed out that Mr. Graves' paper was the first of the kind that had been read before the Society; the period chosen was particularly a happy one, inasmuch as it was coincident with the growth of the Society of Telegraph Engineers. He expressed a hope that a 6d. rate for telegrams would shortly be introduced.

MR. C. E. SPAGNOLETTI, in seconding a vote of thanks, complimented Mr. Graves on the paper he had read, which must have involved a great deal of trouble to get up.

MR. ROBERT GRAY said that as regards the cheapening of telegrams, the traffic on the Marseilles-Algiers cable, which was formerly transmitted at the rate of 2d. per word, could now be sent for 1d. per word, two cables being used for the purpose. The increase in traffic consequent on the reduced rate had quite paid for the new cable.

The PRESIDENT having made some concluding remarks, the meeting adjourned.

AT an extraordinary general meeting of the Society held June 3rd, Mr. W. H. PREECE, President, in the

chair, the minutes of the last general meeting having been read and confirmed, Dr. C. WILLIAM SIEMENS, D.C.L., LL.D., F.R.S., Past President of the Society, read a paper on "The Dynamo-Electric Current in its application to Metallurgy, to Horticulture, and to the Transmission of Power."

Amongst the means at our disposal for effecting the fusion of highly refractory metals, and other substances, none has been more fully recognised than the hydro-oxygen blast. The ingenious modification of the same by M. H. Ste. Claire de Ville, known as the Deville furnace, has been developed and applied for the fusion of platinum in considerable quantities by Mr. George Matthey, F.R.S.

The Regenerative Gas Furnace furnishes, however, another means of attaining extremely high degrees of heat, and this furnace is now largely used in the arts—among other purposes, for the production of mild steel. By the application of the open hearth process, 10 to 15 tons of malleable iron, containing only traces of carbon or other substances alloyed with it, may be seen in a perfectly fluid condition upon the open hearth of the furnace, at a temperature probably not inferior to the melting point of platinum. It may here be remarked that the only building material capable of resisting such heats is a brick composed of 98·5 per cent. of silica, and only 1·5 per cent. of alumina, iron, and lime, to bind the silica together.

In the Deville furnace extreme degrees of heat are obtained by the union of pure oxygen with a rich gaseous fuel under the influence of a blast, whereas in the Siemens' furnace it is due to slow combustion of a poor gas, potentiated, so to speak, by a process of accumulation through heat stores or regenerators.

The degree of heat attainable in both furnaces is limited by the point of complete dissociation of carbonic acid and aqueous vapour, which, according to Ste. Claire de Ville and Bunsen, may be estimated at from 2,500° to 2,800° C. But long before this extreme point has been reached, combustion becomes so sluggish that the losses of heat by radiation balance the production by combustion, and thus prevent further increase of temperature.

It is to the electric arc, therefore, that we must look for the attainment of a temperature exceeding the point of dissociation of products of combustion, a temperature not much inferior to that of the sun.

The object of the paper is to show that the electric arc is not only capable of producing very intense degrees of heat in a focus or extremely contracted space, but also such larger effects of intense heat, with moderate expenditure of energy, as will render it useful in the arts for effecting the fusion of platinum, iridium, steel, or iron, or for such reactions or decompositions as require for their accomplishment an intense degree of heat, coupled with freedom from disturbing influences such as are inseparable from a furnace worked by the combustion of carbonaceous material.

The apparatus employed to effect the electro-fusion of such material as iron or platinum consists of an ordinary crucible of plumbago or other highly refractory material, which is placed in a metallic jacket or outer casing, the intervening space being filled up with pounded charcoal or other bad conductor of heat. A hole is pierced through the bottom of the crucible for the admission of a rod of iron, platinum, or dense carbon, such as is used in electric illumination. The cover of the crucible is also pierced for the reception of the negative electrode, by preference a cylinder of compressed carbon of comparatively large dimensions. At the end of a beam supported at its centre is suspended the negative electrode by means of a strip of copper, or other good conductor of electricity, the other end of the beam being attached to a hollow cylinder of iron free to move vertically within a solenoid coil of wire, presenting a total resistance of about 50 units or ohms. By means of a sliding weight the preponderance of weight of the beam in the direction of the solenoid can be varied so as to balance the magnetic force with which the hollow iron cylinder is drawn into the coil. One end of the solenoid coil is connected with the positive, and the other with the negative pole of the electric arc, and, being a coil of high resistance, its attractive force on the iron cylinder is proportional to the electro-motive force between the two electrodes, or, in other words, to the electrical resistance of the arc itself.

The resistance of the arc was determined and fixed at will within the limits of the source of power, by sliding the weight upon the beam. If the resistance of the arc should increase from any cause, the current passing through the solenoid would gain in strength, and the magnetic force overcoming the counteracting weight would cause the negative electrode to descend deeper into the crucible; whereas, if the resistance of the arc should fall below the desired limit, the weight would drive back the iron cylinder within the coils, and the length of the arc would increase, until the balance between the forces engaged had been re-established.

In working with the modified medium-sized dynamo machine, capable of producing 36 webers of current with an expenditure of 4 horse-power, and which, if used for illuminating purposes, produces a light equal to 6,000 candles, it is found that a crucible of about 20 centimetres in depth, immersed in a non-conductive material, is raised up to a white heat in less than a quarter of an hour, and the fusion of 1 kilogram of steel is effected within, say, another quarter of an hour, successive fusions being effected in somewhat diminishing intervals of time. It is quite feasible to carry on this process upon a still larger scale by increasing the power of the dynamo-electric machine and the size of the crucibles.

The dynamo-electric machine consuming 4·25 horse-power, or 3·17 ergtens, per second, will send a current of 40·5 webers through 1 unit electrical resistance; replacing the resistance by an arc maintained by the balance-weight constantly at 37·8 volts electro-motive force, the same current will flow.

Neglecting the connecting wires, there will be developed in the arc an energy of

$$\begin{aligned} &1{,}531{\cdot}2 \times 10^7 \text{ ergs. per second} = \\ &9{,}187{\cdot}2 \times 10^8 \text{ ergs. per minute} = \\ &1{,}378{\cdot}1 \times 10^{10} \text{ ergs. per 15 minutes} = \\ &32{\cdot}8 + 10^4 \text{ gram water degree units of heat.} \end{aligned}$$

Assuming steel to have the same specific heat as iron, viz., at $t^0 =$

$$\cdot 1040 \times 0{\cdot}000144\, t,$$

and that the melting point of steel is 1,800° C., then 420·5 units of heat will be expended in raising the steel to this temperature; and assuming the latent heat of fusion at 29·5 units (silver is 21, and zinc 28), there are roughly 450 units required to melt a gram of steel, and 225,000 to melt half a kilogram, that is about $\frac{1}{6}$ of the heat generated in the crucible, and $\frac{1}{6}$ of the horse-power actually expended. A good expansive condensing steam engine converts the heat energy residing in coal into mechanical energy, with a loss of about 80 per cent., or, in other words, $\frac{1}{5}$ only of the 7,000 units residing in a gram of ordinary coal is represented as work in the engine. The useful effect attainable in the electric furnace is therefore $\frac{1}{5} \times \frac{1}{6} = \frac{1}{30}$ of the heat energy residing in the fuel consumed under the boiler of the engine.

(*To be continued.*)

New Patents—1880.

2147. "Electric light apparatus." W. L. WISE. (Communicated by J. A. Mandon.) Dated May 26.

2183. "Railway signalling apparatus." C. E. SPAGNOLETTI. Dated May 28.

2207. "Conductors of lightning." O. WOLFF. Communicated by W. Michalk.) Dated May 31.

2208. "An improved fire and burglar alarm." J. McNeill. Dated May 31.

2229. "Improvements in the construction of apparatus for lighting gas, part of which apparatus is also applicable to other electrical appliances." C. L. CLARKE and J. LEIGH. Dated June 1.

2235. "New or improved modes and means or apparatus for signalling or communicating between passengers and servants in railway trains." E. GILBERT and A. E. GILBERT. Dated June 1.

2236. "A new or improved electric lamp with automatic regulation for the purpose of lighting by electricity, and effecting a regular uniform approach of the two electrodes or candles in the proportion as they are consumed." S. COHNÉ. Dated June 1.

2252. "Electric lamps." G. G. ANDRÉ and E. EASTON. Dated June 2.

2272. "Obtaining, increasing, and employing currents of electricity." T. SLATER. Dated June 3.

2305. "Improvements in apparatus for securing the proper relative working of switches, crossings, and signals, and the more certain and effective working of the signalling devices on railways." J. S. WILLIAMS. Dated June 8.

2312. "Improvements in diving bells and in electrical and other apparatus to be employed in connection therewith for submarine or subaqueous operations, parts of which apparatus are applicable for other purposes." W. R. LAKE. (Communicated by C. F. Pike.) Complete. Dated June 8.

2354. "Improvements in and connected with batteries, whereby they are converted into transmitters of sound." R. H. COURTENAY. Dated June 10.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

4170. "Interlocking the telegraphic block instrument with the points and signals of railways." C. HODGSON. Dated October 15. 6d. The apparatus employed for the above and which is intended to give greater security to the traffic of railways, consists of three principal parts; first, a locking handle which can be moved by hand into either of two positions, so as to lock and unlock the point and signal levers; secondly, a commutator with its plunger for making electrical connections, and transmitting telegraphic signals to another station; and thirdly, a detent which is connected to and worked either by one of the ordinary semaphore signals, or by a treadle or trigger acted on by a passing train, the connections for this purpose being either mechanical or electrical.

4298. "Apparatus for transmitting and receiving signals on ships and vessels," &c. FRANK RICARDO FRANCIS. Dated October 22. 8d. Consists in the combination and arrangement of an instrument containing a series of commutators and transmitting keys corresponding to the number of signals required to be employed.

4306. "Automatic contact breakers for electric circuits." THOMAS WILKINS. Dated October 22. 2d. Consists in the use of an air-chamber or vacuum bellows in which a slight leakage is permitted. The said air-chamber or vacuum bellows is connected with the contact surfaces of the electric circuit and the air is expelled from the chamber when the said surfaces are in contact or *vice versa*. In lieu of the air chamber clockwork may be used. *(Provisional only.)*

4346. "Galvanic batteries." R. C. ANDERSON. Dated October 24. 2d. (Relates to batteries described in our last issue.) *(Patent void.)*

4354. "Electric lamps." A. S. HICKLEY. Dated October 25. 6d. Describes lamps similar to those illustrated in this journal.

4400 "Electric apparatus." W. R. LAKE. (A communication from Professors Houston and Thomson.) Dated October 29. 1s. Consists of a dynamo electric machine, the coils of the field magnets being wound conically, the wide portion being placed as near as possible to the revolving armature, and serving thereby, in addition to the ordinary purpose of magnetising the field magnets, to directly influence and strengthen the polarisation of the said armature. Likewise of a regulator lamp, and also of a storage battery. The claims are twenty-seven in number.

4404. "Electric batteries." A. V. NEWTON. (A communication from F. Tommasi.) Dated October 29. 6d. Belong to that class of battery in which two exciting liquids are used, and each cell is an outer vessel, consisting of two cylinders of about equal depth, but of different diameters, joined together end to end. The lower half of this vessel has a smaller diameter, and constitutes the bottom of the vessel. The annular portion which joins the two cylinders together constitutes an annular gutter, and forms a support for a cylinder of zinc, which is attached by cement to the upper half of the vessel. This zinc cylinder is bevilled at its upper periphery, to form between it and the vessel a gutter for the reception of mercury, and in the gutter at the foot of the zinc cylinder mercury is also placed; this for the purpose of maintaining the amalgamation of the zinc. Within the zinc cylinder, and reaching down to the bottom of the outer vessels, a cylindrical porous pot is placed. This pot is glazed at the bottom, and to about one-half its height, or to a level with the bottom edge of the zinc cylinder, and from its top down to a level with the exciting liquid contained in the outer vessel. In this partially porous pot a semi-cylinder of carbon, about half the depth of the pot, is suspended, and a semi-cylinder of glass or earthenware of corresponding bulk is provided, which is also suspended from a rod sliding through a cover with which the cell is fitted. The outer vessel is filled with dilute sulphuric acid, and the porous pot with strong nitric acid. To set the cell in action it is only necessary to depress the semi-cylinder of earthenware in order to displace the nitric acid at the bottom of the pot, and cause it to rise and surround the carbon.

4405. "Electric lamps." A. V. NEWTON. (A communication from F. Tommasi.) Dated October 29. 6d. In constructing a pedestal lamp a carbon block is used, carried by a central rod for a series of carbon electrodes to butt against. These carbon electrodes float in mercury tubes, which incline inwards towards a common centre.

4428. "Electrical apparatus." E. G. BREWER. (A communication from E. A. Chambrier.) Dated October 30. 6d. Consists of a new arrangement of electro-

magnet, whereby the apparatus can be regulated in such a manner as to find the most favourable point for obtaining the maximum of attractive power or force, by making an electric current pass into the bobbins, and also in the deformation or changing of the form of the ordinary plane surfaces of the armature, and of the end of the bar, so as to increase the dimensions of the surface presented.

4440. "Telephones." J. H. Johnson. (A communication from Clement Ader.) Dated October 31. 2d. Relates to the employment in telephones, and especially in the receiving instruments, of a superexciting plate of soft iron, arranged behind the vibrating metallic diaphragm, and at a very short distance from the latter, whereby the sounds emitted are rendered more intense and more distinct than in telephones of the ordinary construction. (*Provisional only.*)

4456. "Apparatus for containing and protecting telegraph wires." J. T. King. (Communicated by C. Linford.) Dated November 1. 2d. Consists in constructing apparatus for containing and protecting telegraph wires of lengths of metal rolled, cast, or otherwise formed, with grooves or channels for containing the wires. The grooved or channelled surface is enamelled with porcelain or other insulating material; the surface of said containers, which are in contact with earth, being tinned or japanned to prevent rusting. (*Provisional only.*)

City Notes.

Old Broad Street, June 14th, 1880.

The directors of the Brazilian Submarine Telegraph Company (Limited) have declared an interim dividend of 2s. 6d. per share, or 5 per cent. per annum free of income tax, for the quarter ended March 31 last.

The office of the Western and Brazilian Telegraph Company is removed to 19, Great Winchester Street.

The office of the Great Northern Telegraph Company is removed to 119, Bishopsgate Street.

The "Compagnie Française du Télégraphe de Paris à New York," having commenced business from London to the United States at a 2s. rate, the Anglo Company have reduced their tariff to 6d. per word, whilst the Direct Company retain theirs at 2s. The London receiving office of the new Company is at 24, Royal Exchange.

The West Coast of America Telegraph Company (Limited).—The third ordinary general meeting was held on the 4th inst. The chairman (Mr. A. R. Johnston) expressed his regret that the final accounts from the stations on the West Coast had not yet been received. They had had a few lines from their general manager at Lima, in which he mentioned that he had forwarded a mail overland which had not then come to hand, but it was not stated whether the accounts had also been sent. They knew that there had been great difficulty in getting the accounts together from the disturbed state of the coast. Very little had happened since their meeting six weeks ago, but he regretted to say that so far as their earnings were concerned matters had not improved in the interval. The war continued to drag along; Mollendo had been entered, and had been more or less destroyed by the Chilian forces, and the Company had thus suffered pretty severely. He did not know that it was anything very great as regarded money, but their property had been destroyed. Part of the instruments, however, had been saved, which would enable them to continue working when they had the opportunity. They were in imminent danger of being driven out of Callao, in which case they would retire on Lima. They were waiting till matters became more settled. As regarded their earnings, he informed them six weeks ago that they were looking better. In January the receipts were an improvement on those of December, and February and March had a further increase, but that seemed to be the turning-point. In April the receipts went back materially, and May was also disappointing, but that was approximate only. After a few remarks by shareholders a discussion ensued on a motion for the appointment as a director of Mr. R. Kendal, and ultimately the motion was carried. The retiring directors and auditors were re-elected, and the proceedings terminated.

The directors of the Western and Brazilian Telegraph Company have issued an interim report together with a balance sheet for the half-year ending 31st March last. It states that after deducting £3,967, balance of "special cable repairs," carried forward from the last balance sheet, a profit of £15,992 has been earned upon the Company's system during this period. The gross receipts from the 1st of October show an increase as compared with the corresponding period of the preceding half-year of £20,521. The question of competition by the Brazilian Government land lines with the Company's system has had the Board's serious consideration, believing, as they do, that it is opposed to the letter and the spirit of the concession under which the cables are worked. Special representations have been made to the Government, and in view of the strength and justice of the case the Board have strong hopes that the competition, as at present carried on, will not be allowed to continue, and the Government of Brazil fulfil in its integrity its pledges to the Company.

The following are the final quotations of telegraphs:—Anglo-American Limited, 59½-60½; Do., Preferred, 90-91; Ditto, Deferred, 32¾-33¼; Black Sea, Limited, ——; Brazilian Submarine, Limited, 8⅜-8⅝; Cuba, Limited, 9¼-9¾; Cuba, Limited, 10 per cent. Preference, 15½-16½; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 10⅝-11⅛; Direct United States Cable, Limited, 1877, 10⅝-11; Scrip of Debentures, 100-102; Do., £50 paid, par-2 pm.; Eastern, Limited, 8⅞-9⅛; Eastern 6 per cent. Preference, 12⅛-12⅜; Eastern, 6 per cent. Debentures, repayable October, 1883, 102-105; Eastern 5 per cent. Debentures, repayable August, 1887, 101-103; Eastern, 5 per cent., repayable Aug., 1899, 103-105; Eastern Extension, Australasian and China, Limited, 9-9¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 107-110; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 103-105; Ditto, registered, repayable 1900, 103-106; German Union Telegraph and Trust, 8½-9; Globe Telegraph and Trust, Limited, 5¾-6; Globe, 6 per cent. Preference, 11¾-12; Great Northern, 9⅝-9⅞; Indo-European, Limited, 22-23; London Platino-Brazilian, Limited, 4¾-5¼; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10⅝-11; Reuter's Limited, 9⅞-10⅜; Submarine, 235-245; Submarine Scrip, 2⅛-2⅜; West Coast of America, Limited, 1⅜-1⅞; West India and Panama, Limited, 1¼-1½; Ditto, 6 per cent. First Preference, 7¼-7¾; Ditto, ditto, Second Preference, 6¾-7; Western and Brazilian, Limited, 7⅜-7⅝; Ditto, 6 per cent. Debentures "A," 100-103, Ditto, ditto, ditto, "B," 100-103; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 117-122; Ditto, 6 per cent. Sterling Bonds, 103-105; Telegraph Construction and Maintenance, Limited, 33⅝-34; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3⅛-3⅜; India Rubber Company, 14¼-14¾; Ditto 6 per cent. Debenture, 104-106;

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 178.

THE ELECTRIC RAILWAY.

Now that the possibility of an Electric Railway has been fairly put before the public by Dr. Siemens, we may expect to hear more about it before many years.

The commercial advantages of the system must, of course, determine whether the Electric Railway will be extensively used or not. The question is not entirely one of economy of fuel, safety and convenience are elements which greatly affect the commercial profitableness of any undertaking, and these must be taken into consideration in making an estimate.

As yet, the new means of locomotion has only been experimented upon on a comparatively small scale, but the results have been quite sufficient to justify a favourable conclusion being drawn.

The idea of an electric railway is by no means new; little model engines, which ran backwards and forwards on a pair of rails, or round and round in a circle, were often to be seen in the windows of the shops of scientific instrument makers in the early days of electrical science, and the suggestion to apply the principle on a large scale was such a natural one that it is necessary to go back to a somewhat early date in the records of the Patent Office to find the first patent for an electrical railway. So long as the motive power was dependent upon galvanic batteries but little success could be obtained, but the introduction of dynamo machines altered the question entirely and brought the idea within the range of economical possibility.

For underground railways the system is specially suitable, and those who travel on the Metropolitan Railway during the dog days must often devoutly hope that some change in this direction will be made at no distant date. Already it is contemplated to work the traffic through the new St. Gothard tunnel by electricity, and plans and designs for the purpose have been in hand.

Railways worked by electricity will, however, have to compete with a formidable rival in the shape of railways worked by compressed air locomotives. This latter means of producing locomotion appears to have woke up again and is likely to have considerable employment.

For very short distances, where the traffic is heavy and irregular, as, for instance, on the small branch lines used so frequently in mining districts, the electrical railway could be used with great advantage, especially if natural sources of power are available.

THE ELECTRICAL TOURNIQUET OF MM. FONVIELLE AND LONTIN.

THIS little instrument, presented to the Académie des Sciences during the April session, is composed of a galvanometer coil, in which is placed a small disc of soft iron, capable of rotation on a pivot which supports it. A horse-shoe magnet is set over the coil in the position shown in fig. 1, so that its polar extremities are close to the coil. If now a current of electricity is sent through the coil from a small induction coil, the disc rotates rapidly in a perfectly definite way, this being dependent upon the position of the poles of the magnet, and upon the nature of the induced currents passing through the coils. When the magnet lies *across* the coil, that is to say, at right angles to the position shown in the figure, then there is no rotation. MM. Jamin and Du Moncel have very simply explained the cause of the phenomenon. It is well known that the induced current generated on *making* the primary circuit is always more powerful than the current produced on *breaking* the same. The soft iron disc being polarised by the outside magnet becomes practically a magnetic needle in a galvanometer coil, and takes its movements under the action of a series of momentary impulses, the poles remaining fixed in space although the disc of soft iron is changed in position by the rotation. The current on breaking the primary circuit, acts in the reverse way to that produced on making, but since its strength is much less than the latter, the disc is acted upon by the difference of the two currents. Each current on *making* produces new impulses on the disc, since the poles find themselves within the field of the fixed magnet. The same movement of rotation is produced *with the direct current of a battery interrupted with great rapidity.* In this case the velocity of rotation is less, but this must be attributed to the fact that the momentary impulses are not produced sufficiently rapidly, and because, on the other hand, the resistance of the galvanometer coil is not such as would utilise the whole effect of the direct current. The movement increases itself when the current of the battery is caused to traverse an induction bobbin with a make and break, for it produces then a series of momentary impulses sufficiently close to one another to communicate to the disc a certain velocity of rotation.

By arranging two tourniquets in series, as seen by fig. 2, it is possible to produce a movement in each coil, but on withdrawing the disc from one of the tourniquets the one left in the other, turns with increased rapidity. This fact can be explained by the well known reactions which take place between magnets and currents.

The movement of rotation is produced with movable pieces of soft iron of various shapes,

needles, stars, plain discs (solid or with spokes), or with spiral bands like the balance-spring of a watch.

If the fixed magnet is removed, then the phenomenon can be produced under the action of the earth's magnetism, but to a small degree only.

The fact of the stoppage produced by placing the magnet at right angles to the position shown in the figures, proves exactly that the theory of M. Jamin is correct, for, in this case, the disc placed inside the galvanometer coil, forms, under the influence of the external magnet, a true magnetic bar placed crosswise to the movement of the current, and consequently, no action should take place under this condition.

The instrument of MM. Lontin and Fonvielle constitutes a new and original method of demonstrating the laws which govern the actions of magnets and currents, and for this reason should be placed side by side with the analogous apparatus of Ritchie, Barlow, Faraday, &c.—*La Nature.*

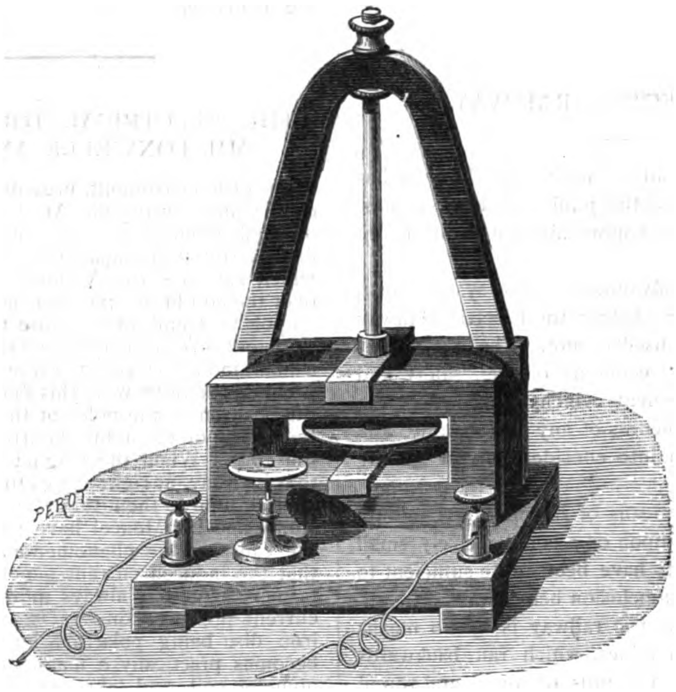


FIG. 1.

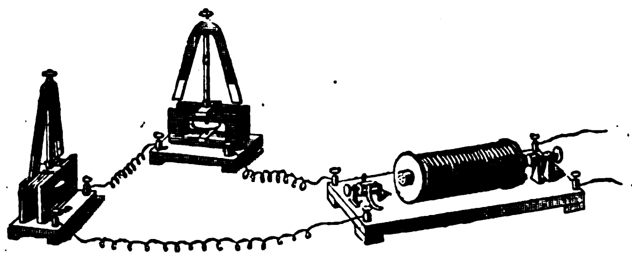


FIG. 2.

THE MARSEILLES-ALGIERS CABLES AND CHEAP TELEGRAMS.

THE number of the *Journal Officiel de la République Française* for June 17th, gives some interesting details concerning the Marseilles-Algiers Cables; it says:—

"The Budget Committee have recommended an expenditure of 1,600,000 francs for the laying of a new Marseilles-Algiers cable. They add to their recommendation the following data. Algeria is in communication with Marseilles by means of three* submarine cables. One (*sic*) of these cables is the property of an English company, who work

* There are actually *four* cab'es.—ED. TEL. JOUR.

it for their own profit. The two other cables belong to the French Government. The first was laid in 1871, and the second in 1879. The number of messages transmitted by the 1871 cable rose to 143,942 in 1878. The tariff at that date was 20 centimes (2d.) per word. By a decree of 25th August, 1879, this rate was reduced to 10 centimes (1d.) per word. Almost immediately, the number of messages doubled, and, in a very short time afterwards, the total receipts exceeded those of any preceding year, in spite of the fact that the rate had been reduced by 50 per cent. This product was 610,544 francs in 1878, which rose to 647,646 francs in 1879 (when, be it noted, the half rate had been in force for five months) and it now appears, from results obtained up to the 1st April, 1880, that the receipts for the present year will not be less than 718,760 francs. Up to the present time it has been found possible to meet this increasing traffic, but on several occasions a great difficulty has been found in getting rid of a press of business. This, with the fact that the 1871 cable is faulty, and is consequently not trustworthy, render imperative the laying of a new cable.

"The laying of a new cable being indispensable, your committee advises the Chamber to vote the 1,600,000 francs necessary to establish a new line. This recommendation was afterwards adopted by the Chamber and the amount voted."

It may be well to add that the two direct cables now existing are each 500 nautical miles long, and that the cost of the last one was only £57,200. Taking the two cables at £114,200 and the produce of 1d. per word rate at 710,760 francs, or £28,430, an excellent revenue results; roughly speaking, 25 per cent. per annum. The expenses should not exceed £7,000 or £8,000 at a very liberal estimate, subtracting this amount, the net revenue or interest on the capital expended amounts to 19 per cent. per annum. Here we have 1d. per word for messages passing through 500 miles of submarine telegraph cable producing a higher rate of interest than that paid by any of our submarine lines, the Submarine Telegraph Company coming second, 2 per cent. per annum under. It is a matter of congratulation to the French Government that through their enlightened policy of cheap rates they should stand first, from a money-making point of view.

ON A SIMPLE METHOD OF IDENTIFYING A SUBMERGED TELEGRAPH CABLE WITHOUT CUTTING IT.

By W. P. JOHNSTON, Officiating Electrician, Indian Government Telegraphs.

THE following paper from the June number of the *Philosophical Magazine* being of great interest and practical value to telegraphists, we are induced to reprint it in full.

"Circumstances having arisen which rendered it desirable, and at times absolutely necessary, to be in possession of a method for identifying a submerged telegraph cable by applying certain tests to the protecting guards, the following experiments were made for the purpose."

The particular case referred to me was this :—

"How with two cables (one good and one faulty) across a river, both cables having similar guards, can one be distinguished from the other without cutting, when either one of them has been raised from the bottom on to the repairing boat? The boat being a small one, and the river running rapidly, it becomes difficult and dangerous to cut the cable in the first instance; and to make a joint simply for the purpose of identification is above all things to be avoided."

My first idea was to attach a very sensitive instrument to the guards where they were raised out of the water, to signal from the bank through the guards, and to observe the effects on this instrument, first, when the battery and instrument were joined to the guards of the same cable, and, secondly, when the battery was joined to the guards of one, and the instrument to the guards of the other cable. This, however, did not answer.

My next idea was to join an instrument to the guards, and to observe whether it was sufficiently sensitive to show any sign of the current that would be induced in the guards of the cable when a strong current was sent through the conductor; and on mentioning this to Mr. J. J. Allen, Assistant Superintendent of Indian Government Telegraphs, he suggested that in this case a telephone attached to the guards might be influenced. The value of this suggestion was clear to me; for I have reason to know how exceedingly sensitive an instrument the telephone is, having about a year ago made for Mr. Schwendler the experiment to convey messages from one bank of a river to the other without any conductor between the two banks but the water, which experiment was for a certain distance quite successful.

I may now be allowed to detail the experiments which I made with the telephone.

A B is a submerged telegraph cable about 7,300 yards long, and having an absolute translation-resistance of 580 megohms;

——— is the conductor of copper of 23 ohms resistance; the helical line represents the guards, 12 galvanised iron wires each weighing 900 lb. per mile;

C D the portion of the cable raised to the repairing boat;

E the signalling battery, joined to the conductor;

T the telephone, of 2·5 ohms resistance.

The distance C D being 12 yards, every signal that was sent through the conductor was distinctly audible on the telephone (T); reducing the distance gradually, the signals were still readable so long as that distance was not less than 6 feet. At a less distance the signals became faint; and at 3 inches only an exceedingly feeble sound could just be heard, and not sufficient for reading.

On pressing the key a sound was heard from the telephone; and on releasing the key a sound was also heard.

The explanation, of course, is simple :—"For every current made in the conductor, a current is induced in the iron guards in the opposite direction to the primary current; and for every interruption made, a current is induced in the iron guards in the same direction as the primary current. The telephone therefore receives a succession of opposite currents; and being such an exceedingly sensitive instrument, notwithstanding the very minute fraction of these induced currents which passes through the shunt

formed by the telephone, still it gives out audible sound."

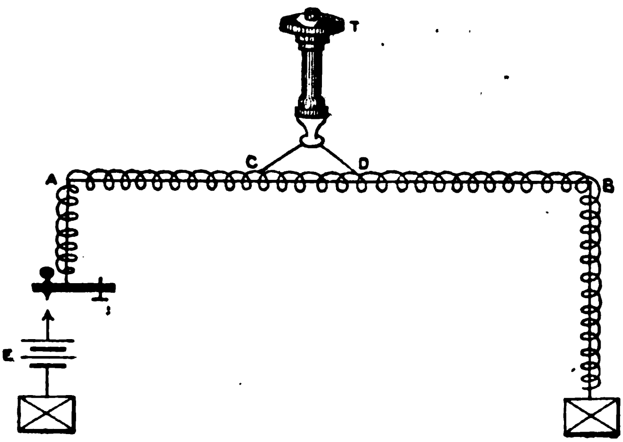
As stated before, the guards were 12 galvanised iron wires each weighing 900 lb. per mile, and

the resistance per mile of one 900-lb. wire = 7 ohms,

the resistance per mile of twelve 900-lb. wires = $\frac{7}{12}$ ohm,

and the resistance of 6 feet of twelve 900-lb. wires = 0·66 milliohm.

In this case the resistance of 0·66 milliohm offered by the 6 feet of the guards was shunted by a telephone offering with its connecting wires a resistance of 2·5 ohms. Therefore, of the currents induced in the guards by the primary current in the conductor, only $\frac{1}{3800}$ passed through the telephone.



The method which I suggest for the identification of a submerged telegraph cable is therefore as follows:—Attach a telephone of low resistance to the guards of the raised portion of the cable (which portion may be either in or out of the water), as shown in the diagram, and send signals from the bank through the conductor of one of the cables; and then, if the telephone is connected to the guards of the cable through the conductor of which the signals are being sent, those signals will be audible in the telephone.

There are doubtless many other cases in which this method may be found of practical service.

The telephone in its short history resembles very much the development of a boy whose father had brought him up to be a priest, but who, contrary to all expectations, turned out to be a general; for the application in practical telegraphy for which the telephone was invented has not turned out to be so successful as the inventor, Prof. Bell, and others anticipated. But instead of this, the instrument will undoubtedly become of the greatest assistance to physical research. In addition to signalling across rivers already referred to, Mr. Schwendler had already used the telephone for indicating the speed of the induction cylinder of a dynamo-electric machine (see *précis* of his Electric Light Report); and Professor Hughes has used it with great success in his induction-balance. It seems, in fact, the telephone is too sensitive and too quick working for practical use."

Calcutta, April 27th, 1880

THE JAMIN ELECTRIC LIGHT SYSTEM.

Memoir presented by M. Jamin to the Académie des Sciences, May 31st, 1880.

"I HAD the honour to submit to the Academy during its meeting of the 17th March, 1879, the principle of a new electric burner. I have since constructed a novel form of lamp, which I am about to describe. It rests on a slate base which can be fixed in globes or lanterns, according to the style of ornament required, and which supports near the base a grooved copper horseshoe, H, H, H, which is broad, but, at the same time, sufficiently thin to avoid shadows being cast; at the top of the horseshoe is a hollow soft iron piece, G, whose function is to magnetise and attract a movable armature, E, F. The alternate current from a Gramme machine passes first through a thin copper wire, wound three or four times round in the hollow of the horseshoe piece, H, H; this constitutes the circuit director. It is in the middle of this frame and in the same plane with it that the electric candles, or carbon couples, are placed, between which the arc is formed. There are three of these candles shown, but a greater number can be used if necessary. Each carbon is introduced in a tubular support of copper, so that they are held vertically, being clipped by a spring. The operation of fixing does not present any difficulties. There is no insulating material between the carbons. Those to the right, B, A, ... are fixed and vertical; those to the left *a*, ... hang freely on joints, B, B′, B″, ...; the ends of their supports are held by a bar, C, C′, which presses them all to one side; the armature, E, F, is connected by a lever, E, D, to this bar, which is pressed to the left by its weight; this causes the carbons to approach and touch against their fixed neighbours. It may be remarked that the contact

is only made between one of the carbon pairs, that is to say, between the longest, or the pair whose points are closest together; it is this one which lights.

"The electric current, after having traversed the directing circuit, arrives at the same time at the three movable carbons and can return indifferently by the three fixed ones; it passes between those which touch and lights them. Immediately magnetisation takes place, the armature, E, F, is attracted, the three carbon couples separate together, two remaining cold and the arc burning between the third. It remains so as long as there is material to be consumed, being maintained at the points by the action of the directing current, and recovering necessarily if any external cause disturbs it. When

"When the combustion of the candle reaches the wire, it melts the latter and releases the carbon immediately, and the two instantly separate; the arc is broken, but it is immediately reformed on a neighbouring candle. The action is so sharp that the change to the new candle can scarcely be perceived, and the other lamps in the circuit are not affected. It must be remarked that this substitution of one candle for another only takes place every two hours, and as the brass wire is only burnt at its extremity, it is only necessary to cut the end off and pull a little more through the fillet, and then to twist it round the new carbon, so that a short piece lasts for a long time.

"One of the great inconveniences of the electric light is the possible and sudden extinction of one of

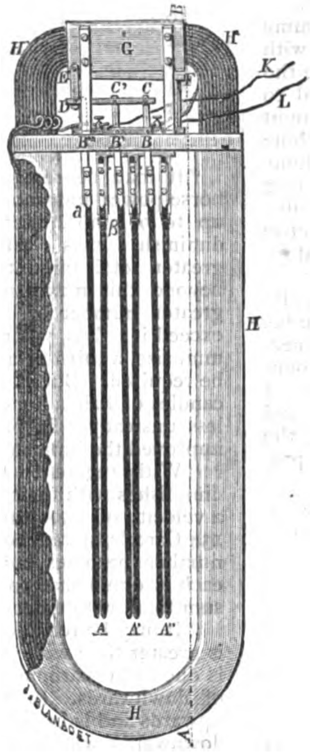


FIG. 1.

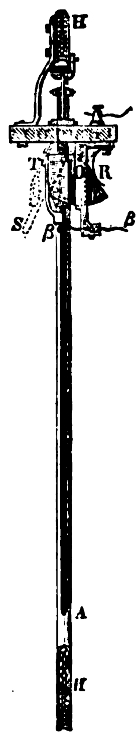


FIG. 2.

the current is stopped, the armature falls back and immediately re-establishes the contact; if it passes afresh, the carbons relight and separate as at first. Thus the lighting is automatic, instantaneous, and renewable at will.

"When the first candle is consumed it must have its place taken by another. To effect this, the carbon holder to the left, which remained fixed, is hinged at its end and can move aside, not in the same plane as the horseshoe, but at right angles to this (fig. 2). It is pushed by a spring, R, which separates it, but it is maintained in the vertical position by a brass wire, B, hooked at the end, and which passes friction tight through a fillet, being pressed by a spring.

the lamps, which causes all the others in the same circuit to become extinguished also, no matter in how good condition they may be. The Jamin candles are not subject to this inconvenience, as it was foreseen and remedied. To this end one of my pupils, M. Krouchkoll, has devised a parachute system, a description of which would be too lengthy; it effects, 1st, the opening, at the moment when the accident occurs, of a secondary circuit which bridges over the defective candle; 2nd, it replaces the defective candle by an equal resistance, which allows the others in the circuit to burn without change. This addition is very important, as it allows more or less candles to be lighted without a change in their light.

"To resume, my lamp contains several novel points; it lights and relights as often as required; it requires only one circuit for all the neighbouring candles; it replaces automatically those candles which have burnt out, with entirely new carbons; it does not employ any insulating material of a nature to change the colour of the flames, nor any preliminary preparation of the carbons, this decidedly diminishes the expense. If, at commencing, it shows, like all others, variations in the brilliancy, this will be due, not to a defect in the lamp itself but to a defect in the carbons; these variations have disappeared since, thanks to M. Carré, the necessary homogeneity has been given to the carbons. It remains, then, to say how much light can be obtained with a given amount of work, what is the quality of the light and of the heat produced, and to what distance can it be conducted.

"I have employed in these researches a Gramme machine; it was driven by an Otto gas-engine, with which it is possible at any instant to measure the work consumed, which is exactly proportional to the number of explosions; it is sufficient to count them. It is well known that the Gramme machine is composed of two distinct parts; the light machine, formed by electro-magnets turning rapidly in a ring of iron wound with inducing wires, and an excitor with continuous currents, which serves to magnetise the electro-magnets. It only does the preparatory work.

"The current which is produced increases rapidly with the velocity. However small the machine be, the necessary magnetisation can always be attained, but one is obliged to expend a considerable amount of power, limited by the heating of the machine. I have succeeded, by theoretical considerations, and by a better distribution of the wire, in reducing the heat to a quarter and the expense to a third, producing, at the same time, the same effect.

	First machine.	Improved machine.
Expenditure of horse-power ...	1·394	0·51
Current strength	·98	·90
Velocity	1,447	1,433

"The expenditure of work, reduced to half a horse-power, is insignificant.

"Different types of Gramme machines have been constructed for electric lighting; the large and more costly ones will light 24 candles of ·004 mm. size; the smaller ones are capable of working 4 candles. I have noticed that these last machines are so feeble that they cannot be employed with advantage. When a low velocity is given them, they take little force to drive them; when this speed is increased to 2,500 turns, they absorb about 10 horse-power, and, as this work is transformed into heat in the circuits, it is evident that one ought to be able to light a number of lights, and obtain a larger amount of light in proportion, as the velocity is greater.

"However, this is not found to be the case, because the heat developed in the machine is such that the insulation of its wires becomes destroyed. It was very easy to remedy this defect by diminishing the resistance of the machine and increasing that of the circuit; this has been done with complete success, and allows of 24 lights being obtained with an 8 horse-power engine.

"I will simply give here the results of one of a number of experiments:—

VELOCITY: 1,530.

Number of lamps.	Intensity.		Horse-power expended.	
	Of each lamp.	Total.	Total.	Each Candle.
1	134	134	2·81	2·81
2	113	226	3·50	1·79
3	107	321	4·07	1·38
4	105	420	4·43	1·11
5	95	475	4·70	·94
6	96	576	4·91	·82
7	93	651	5·04	·72
8	92	736	5·11	·64
9	86	764	5·09	·57
10	74	740	5·07	·51
11	70	771	5·04	·46
12	62	740	5·01	·42
13	56	718	4·80	·37
14	50	700	4·60	·32

"It may be remarked that the expenditure of horse-power and amount of light obtained augments up to 9 lamps, after which these two quantities diminish. It is clear that, if we wish to have a greater total amount of light, we must not go beyond this maximum, but if we wish to have a greater number of lights, more feeble, we must exceed it; thus, when we have 14 candles of ·004 mm. size, a third of a horse-power each only will be required. But it would be better to stop a 2 candles of half a horse-power; they are finer and less unsteady. In proportion as the carbons are improved the limit may be overstepped.

"With regard to the light from each lamp, it diminishes with their number; a single lamp with a velocity of 1,500 turns will give a light equal to 134 Carcels, 2 reduces each to 113, and when the number becomes increased to 14, the light from each is diminished to 50; this is the division of a sum total, with a decreasing quotient.

"It may be remarked that this quantity of light is greater than with the ordinary candles; the cause is due to the carbons, which burn upwards instead of downwards. In one case the light is thrown upwards and is lost; in the other case it is thrown downwards, which is what is required. On the other hand, the flame of the arc, which tends always to rise, leaves the points and does not heat them when they are directed upwards; on the contrary, it envelopes them, and surrounds them with an atmosphere at an enormous temperature when they are turned downwards; this notably increases the amount of light given out. A photometric comparison of two identical candles in the same circuit has shown that the light from the turned down points is five times as great as that obtained with the points turned down. Although their temperature is enormous, the quantity of heat is not great, because the heat focus is small. I have compared this heat with that of a Carcel, by placing successively this lamp and an electric burner in the same calorimeter. The lights being equal, the combustion of the oil developed 45 times as much heat as did the electric arc.

"It remains for me to speak of the distance to which the light can be conveyed; it is greater in proportion as the velocity of the machine is greater; with 1,500 turns it is possible to introduce in the circuit 1 kilometre of copper wire ·001 millimetres in diameter without sensibly diminishing the light; with 2,000 turns 4 kilometres of this wire, or 16 kilometres of wire ·002 millimetres in diameter, can be introduced with a similar result. It is thus possible to conceive that a large town can be lighted from a single source.

"The experiments and numerous trials which I have been able to make with the motors and the machines have been a great tax upon my resources. I have, therefore, been very fortunate in having been assisted in every way by M. Durrieu, President of the Société du Crédit Industriel et Commercial. I am also equally indebted to the indefatigable exertions of M. Denayrouze, private tutor at the Ecole Polytechnique. I have also to thank MM. Maneuvrier and Krouchkoll for having so skilfully assisted me in taking the measurements."

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XII.

(Supplement to Article VIII.)

SOUNDERS.

BESIDES the forms of sounders shown on page 154 (Article VIII.), the instrument, fig. 53, is used to some extent for direct working. In this apparatus the sounder and galvanometer are combined on one base; the magnet is set horizontally instead of vertically, and an adjustment similar to that provided in the Morse Direct Writer Instrument (Article IV.) is provided, viz., the whole magnet can be shifted backwards or forwards by means of a screw, the electro-magnet sliding in a support. Such an adjustment is more necessary in direct working instruments than in those worked by a local battery, as the currents from the latter do not vary under ordinary conditions, to any appreciable extent, whereas the "line" current is continually changing. Beyond this adjustment there is nothing peculiar in the construction of the instrument which calls for remark, or which cannot be seen in the fig. The resistance of the electro-magnet of the instrument is 300 ohms, and the galvanometer 40 ohms, and good signals are given with about 5 milliwebers of current.

As has been previously pointed out, "Direct" Sounders are only worked to a limited extent in the Postal Service.

SINGLE CURRENT DUPLEX SYSTEM, WITH RELAY.

This system is employed on circuits of moderate length, which are beyond the range of the Direct Writer Duplex, but which, at the same time, are not sufficiently long to render the use of the Double Current system necessary.

The arrangement of the apparatus is very similar to that employed with the Double Current system; it is indicated by fig. 54. As compared with the latter system, it will be seen that the only difference that exists lies in the key, which is of the ordinary single current form.

The connections shown are those for an "Up" station; at a "Down" station the connections are similar, with the exception that the battery is reversed. The principle of the working of the system is exactly like that of the Direct Writer Duplex, that is to say, the relay is actuated in the same manner as is the electro-magnet in that system.

Rheostats.

The form of rheostat most generally employed by the Post Office is shown by fig. 55. The apparatus consists of a number of coils enclosed in a circular brass box with an ebonite top; two movable radial arms are provided, whose ends ride over and make contact with little platinum nipple contacts arranged in a circle around the circumference of the face of the ebonite top. Between these contacts the resistance coils of German silver wire are connected. The under ends of the radial arms are provided with spring platinum contacts which rub against the nipples referred to. A slight nick is filed in the contact of each spring into which the ends of the nipples fit, this keeps the arms steady in the positions to which they are moved.

The breadth of the ends of the spring contacts is such that contact is made with one nipple before it is broken with the preceding one, thus no interruption in the continuity of the circuit is caused when making an adjustment, nor can a disconnection be caused by the arms being set intermediate between two contacts instead of being moved so that the nipples fit into the nicks of the spring contacts, as should be the case.

The resistances in the apparatus are of the following values:—40, 80, 120, 160, 200, 240, 280, 320, 360, 400; these resistances are put in circuit by one of the radial arms; the second arm has resistances connected with it of the following values:—400, 800, 1,200, 1,600, 2,000, 2,400, 2,800, 3,200, 3,600, 4,000.

In front of the instrument 3 plug holes are provided, between which are inserted resistances of the values, 10, 20, and 4,000. The first two of these resistances, namely, 10 and 20, are used for making finer adjustments than are possible by means of the radial arms; the lower resistances connected to the latter, it will be noticed, progress in steps of 40 ohms each, but it is found that in bad weather a balance is very easily upset by a slight incorrectness in the resistance, and that a difference of 40 ohms was sufficient to cause this; by means of the two plug resistances referred to, the adjustment can be made within 10 ohms, which answers every purpose. The 4,000 ohms plug resistance is only used on very long circuits, where the balancing resistances required exceed 4,400 ohms.

The form of rheostat shown is better than a set of plug resistances, for when there are a number of plugs the latter are often knocked out accidentally or become loose in their holes.

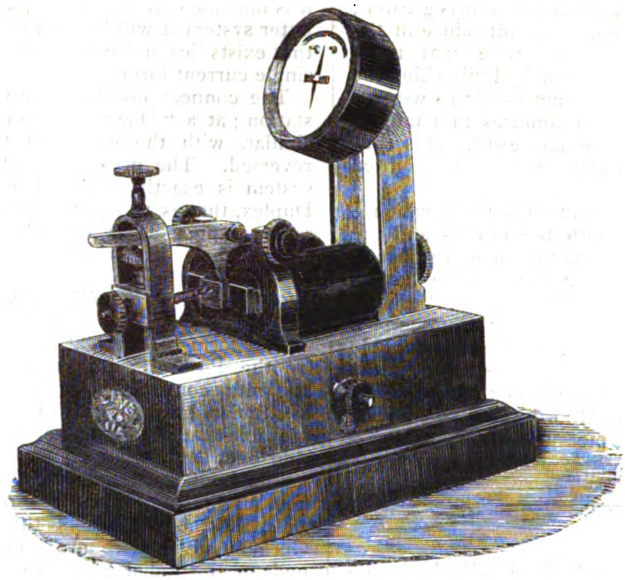


FIG. 53.

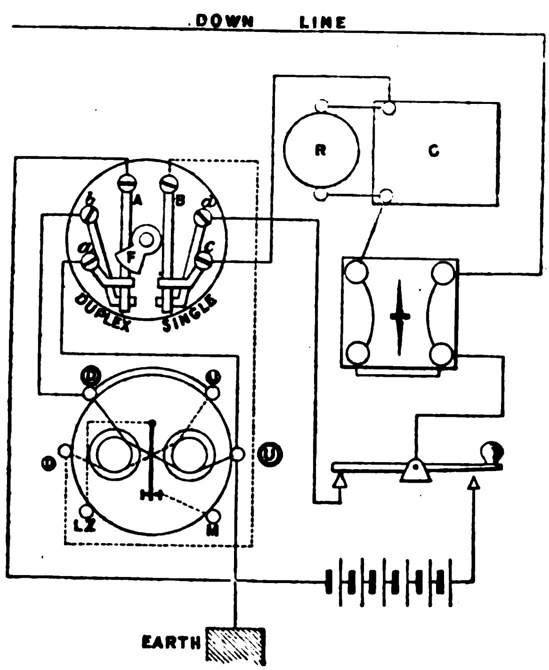


FIG. 54.

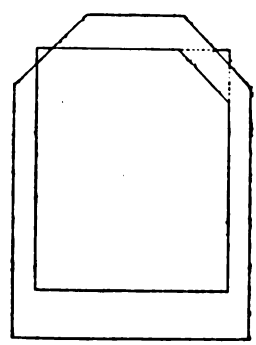


FIG. 57.

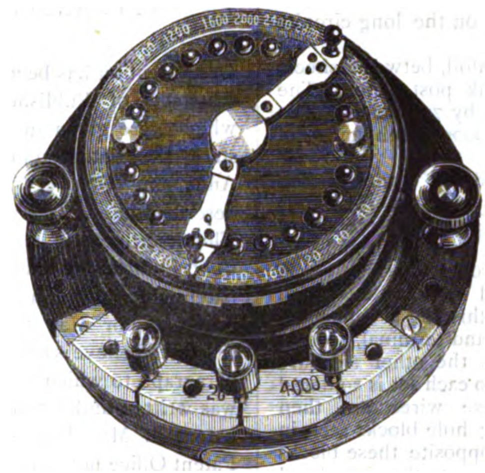


FIG. 55.

FIG. 56.

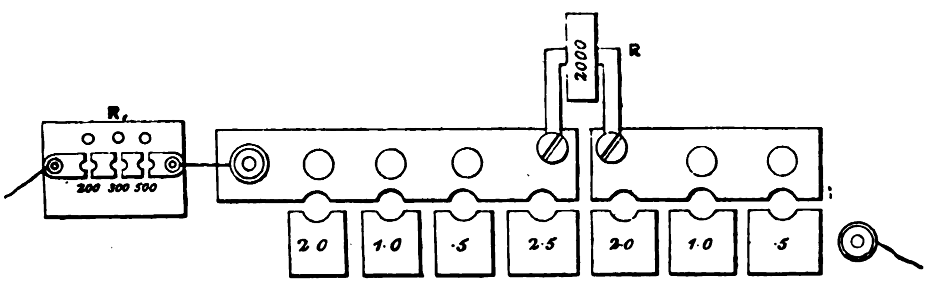


FIG. 58.

Condensers.

The form of condenser used on the long circuits is shown by fig. 56.

The plates are formed of tinfoil, between sheets of paraffined cream wove bank post paper. The paper is cut to the size of 8·55 by 7·3 inches. The tinfoil is of the thickness of ·00097 inch, and is of the size of 7·25 by 6 inches.

Two corners of the paper and one corner of each tinfoil are cut off, as shown by fig. 57. The foils and paraffined papers are laid together in layers, two papers being between each foil; the right and left-hand cut corners of the foils come alternately. A small copper lug is soldered to all the tinfoil corners on the one side, and this lug is connected by a piece of wire to the left-hand terminal, seen in fig. 56. The tinfoil corners on the other side are bunched together in sets, and to each set is soldered a copper lug and wire; these wires are then severally connected to the plug hole blocks seen in fig. 55. The long brass bar opposite these blocks is connected to the terminal seen to the right hand of the figure.

In setting up a condenser, the papers are first well dried, and then each in succession is placed on a heated plate and hot paraffin wax is brushed over by means of a camel-hair brush, a foil is then placed in the centre of the sheet and brushed over with paraffin, it is then carefully smoothed down with a piece of wood faced with soft leather; the foil is then covered with two sheets of the paraffined paper, and then another foil is laid on, and so on until the set is built up. Finally, the whole is subjected to pressure, to press out the surplus paraffin and to consolidate the mass.

The number of plates required to give one microfarad capacity is 57, that is to say, 28 foils between 29.

The whole number of plates, as was pointed out, is divided into sets, their respective capacities being 3·00, 1·00, 1·00, ·50, ·25 microfarads.

The amount of condenser power required to balance the static charge on a duplex circuit is a variable quantity, but in England about one or one and a half microfarads for every 100 ohms of line resistance seems to be about the average. Less capacity is required, as a rule, in wet weather than in fine, the cause being due to the fact that in wet weather only a portion of the charge in the line is discharged at the end and has to be counteracted by the action of the condenser; the remainder of the charge is lost through leakage.

On lines of a considerable length it is found that the charge and discharge of the line does not take place instantaneously, as is the case with a condenser; to get over this difficulty, which is more or less felt on every long circuit, resistance coils are introduced in the condenser circuit which retards the charge and discharge, and thus assimilates its action to that of the line.

The arrangement which has been adopted to effect the required result will be seen from fig. 58. The long bar of the ordinary condenser is cut in two and a resistance of 2,000 ohms inserted in the gap, this resistance it is not found necessary to alter. A resistance box with three resistances of the values 200, 300, and 500 ohms respectively is also included in the circuit, in the position shown, and through this the condenser discharge must take place.

R. C. ANDERSON'S BATTERY.

OUR attention has been called to a paragraph in our Abstracts of Published Specifications of Patents which were given in our last issue; it was there stated that Patent 4346. "Galvanic batteries. R. C. Anderson, October 24th," relates to batteries described in our last issue (June 1st), and is void. The description of Mr. Anderson's battery referred to was written as a description of certain batteries patented by him in a patent No. 3436, abstracted in our issue for May 1st, which patent we have no reason to believe is other than perfectly good, and the paragraph to which our attention has been drawn was written under the impression that the second patent of Mr. Anderson, which is stated in the Patent Office notices to be void, related to the same subject matter. In order to prevent any misapprehension we think it desirable to point out clearly that the batteries of Mr. Anderson, as described in our issue for June 1st, are manufactured under his former and good patent, and *not* under the later and void one.

Notes.

THE French Patent rights of the Otto Silent Gas Engine have been purchased by the Jamin Electric Light Company.

THE engineer for the Jamin Company is M. J. Berly, who no longer represents the interests of the Société Générale de l'Electricité, which, at present, works the Jablochkoff system.

IN our article describing Varley's Patent Time Ball we omitted to mention that the apparatus was constructed by Messrs. Siebe and Gorman, of the Westminster Bridge Road.

THE Postal authorities have issued instructions to the "Always open" offices that at every hour and a half attention must be directed to all the receiving instruments in the office, so that if a call is made it may be attended to and a message taken off, although the call may be made out of the usual business hours. It will thus be possible to send a message from any small town at any hour, provided the postmaster or instrument clerk can be found, and the need for the message being sent be shown to be urgent. The fee for such messages is 2s. extra.

THE Postal authorities of Berlin are considering the advisableness and practicability of providing the public with a telephonic service, to be worked in connection with the telegraphic system.

THE ELECTRIC LIGHT.—In a report to Sir E. Thornton, Mr. V. Drummond, of the Washington Legation, says:—"Mr. Edison's electric light cannot be said to have reached the successful point intended:

the trials are not, however, yet finished; when they are the results will be more clearly proved. The Brush electric light, however, seems to be successful for manufacturing purposes, as will be noticed from the following:—The electric light is coming into extensive use for a great variety of manufacturing purposes. The Telegraph Supply Company of Cleveland, O., report that they have sold over 1,000 Brush (electric) lights for use in rolling mills, machine shops, factories, and similar uses, displacing over 20,000 gas burners. One of the mills—the Riverside Worsted Mills of Providence—has used this light for nearly a year with excellent results. The managers, speaking of the success of the experiment, say 'that the lights could not have a severer test than we give them, as our mills run night and day the year through, and we have not had a moment's delay from, or a dollar's worth of repairs on, any of the machines or lamps. The light is all we expected; it is strong and steady, clear and white; it is universally liked by both overseers and help, so much so that we doubt if we could get along now with the help if we were to return to the old gas lighting, certainly we should not get so good work, nor so much of it. We use ground glass globes pretty generally throughout the mill, and we have less complaint of trouble to the eyes than we used to have with gas. The air of the room, too, shows a very marked difference. With the electric light the air is as good as in the daytime, and noticeably cooler. We had formerly about 250 gas burners of seventeen candle-power each, a total of 4,250 candle-power. We now have 20 electric lamps of 2,000 candle-power each, a total of 40,000 candle-power. Owing to some changes preparatory to setting up new machinery, all our 80 lamps are not at this moment in full service, but by actual count we have 71 lamps permanently placed, and these displace 578 gas burners; that is, there are 578 burners already placed that would be lighted were the electric lights stopped. Estimating these burners at 6 feet per hour, we should use 3,468 cubic feet of gas per hour, costing at 2 dollars per 1,000 cubic feet, 6 dols. 93c. per hour. The actual cost of the electric light is as follows:—The 71 lamps consume carbons, 80 cents.; power used for machines, 65c.; interest on cost of machines, say 15,000 dols. 30c.; men to run machines and lamps, 33c.; oil, wear and tear, &c., 3c. Total cost per hour, 2 dols. 50c.; making a saving of 4 dols. 73c. per hour, and this saving, for the 3,000 hours the machines run in the year, is 14,190 dols.'"

WE understand that the Brooks' underground system is to be tried by the Post Office authorities on a short distance from Waterloo to Vauxhall.

AN ELECTRICAL METEOR.—Mr. Pogson, British Vice-Consul at Hamburg, writes under date June 12th:—"A series of thunderstorms has lately passed over Hamburg. During the 11th inst. the air was densely charged with electricity; the storm broke about 10·15 p.m., lasting until 11 p.m., during which time, at very short intervals, from my station, about 1,200 yards distant from the copper-roofed tower of the church known as St. Jacobi, about 300ft. high, I saw this phenomenon apparently resting about 30ft. from the summit of the steeple. The colour was a reddish purple, and reminded one somewhat of burning potassium. From repeated comparisons with other objects during the lightning flashes, I judged these fire-balls (two were several times visible) to be from 4ft. to 6ft. in diameter. The longest duration that I timed was 42 seconds. This passing away of such dense masses of electricity by induction was visible some twenty times, but whether performed silently I had no means of ascertaining. From the apparent size of the flame and the non-lighting quality of the colour, I estimated it as equal to 10,000 candles. The colour was doubtless the effect of the glare of the copper roof."

THE Anglo-American Electric Light Company have taken the extensive premises known as the Victoria Works, Lambeth, for manufacturing purposes. A large engine and boilers by Messrs. Galloway are now being fitted up.

AT the commencement of 1879, Russia possessed 93,690 versts of telegraph line and 2,516 offices. 70,356 versts of the line is owned by the Government.

THE *Journal de Physique* for May contains a description of some investigations by Professor Colley of Kasan, on the phenomenon of luminosity of a negative electrode of small surface used in electrolysis, the liquid being acidulated water. The light which appears at the electrode was examined with a rotating mirror, and there were noticed a number of bright star-like points appearing only for an instant on a weakly luminous ground. The spectrum of the light was found to be composed of bright lines.

400 Jablochkoff candles were nightly burnt from June 1st to 10th, at the Palais de l'Industrie, Paris, the occasion being a floral exhibition. The effect was said to be magnificent.

ELECTRIC LIGHTS ON BUOYS.—The whistling buoys now in use weigh about fifteen tons each, and in their plunging, even during calm weather, a force of nearly three horse-power is evolved. To utilise this waste energy Mr. Edison has devised a small dynamo machine to be carried by the buoy, the current from which will sustain an electric light equal to one gas jet. If successful, these self illuminating buoys must be of great use to mariners.—*Scientific American.*

SOME experiments have been recently made on the Australian cables to show the distance to which messages can be transmitted; messages were exchanged between Melbourne and Port Darwin, a distance of 2,500 miles. The cable between Port Darwin and Singapore was then put into the circuit, and messages received in a few seconds, the signals being simultaneously repeated at Port Darwin.

MR. CYRUS W. FIELD, of Atlantic Cable celebrity, has prepared a map showing the telegraphic lines already constructed and in operation, and those which yet remain to be established to complete the telegraphic girdle about the world. The missing link is a section from some point on the Pacific coast to the Sandwich Islands, and thence to China and Japan. For this last, Mr. Field is understood to have secured important governmental concessions in connection with projected lines.

A NEW telephone has been devised by M. Marche of Paris. The instrument, which the inventor calls an "electrophone," is worked by means of an induction coil and is said to give very satisfactory results.

A NEW telephone has been recently described to the Paris Academy by M. Ader. The instrument consists of a disc of iron forming an armature and placed before the diaphragm of an ordinary Bell telephone. The centre of the disc is pierced with a hole similar in size to the opening in the mouth-piece of the instrument. This receiver worked with a microphonic transmitter gives

excellent results. M. Du Moncel explains the effect as due to the superexcitation which the armature produces in the magnet. The maximum effect appears to be obtained when the mass of the armature is equal to that of the magnet.

ELECTRIC light experiments on a large scale will be conducted with Wilde candles at the Universal Exhibition of Melun. The gardens will be opened every night and lighted by electricity.

SCOTTISH TELEPHONE EXCHANGE.—This company has now started its central telephone exchange in Edinburgh. The switching offices are 90a, George Street, and 68, Constitution Street, Leith. The rental to be paid varies from £10 to £20 a year, according to the facilities required. Call stations will be opened in different parts of Edinburgh and Leith for the use of subscribers. At present No. 34, St. Andrew Square, and 4, St. Gile's Street, can be used for the purpose.

IT has been resolved by the Philosophical Society of Glasgow to hold an exhibition of apparatus, illustrative of the most recent developments in the use of gas, electricity, &c., for lighting and other purposes. The scheme has been actively countenanced and encouraged by the gas and water committees of the Town Council, to whom the best thanks of the Society are therefore due. The range of subjects to be illustrated by the exhibition will include apparatus, appliances, models, or drawings that relate to, or illustrate, coal gas, oils, oil gases, candles; electricity and its generation and application to lighting purposes; architectural appliances relating to lighting, ventilation, heating, and lightning conduction; miscellaneous apparatus, such as gas-lighted buoys, fog horns, miners' safety lamps, fire-damp indicators, &c. Awards for merit will be given for such classes of exhibits as the committee and exhibitors may arrange to be tested, or such other exhibits as may possess very special merit.

IMPROVED TELEPHONE CALL.—The *Boston Advertiser* describes an improved telephone call signal, which is about to be introduced in that city. It is not of application where a subscriber has a private wire, but is for use in the smaller cities where several subscribers are on the same wire, and, when one is called, all hear the bell, and each must have his separate call. It is a device by which only the person desired may be called and so, without any particular style of call, as at present, he knows whenever he hears the bell that it is for him. The apparatus is something like this:—At the central office is a clock which regulates a clock in the office of each subscriber on the circuit, so that they all run in exactly the same time. This is done by setting the subscribers' clocks, so that whatever variation they have will make them faster than the central clock, and by a current of electricity they are made correct once in every minute. Upon the faces of these clocks and the central one is a dial around the second hand, marked off into as many divisions as there are subscribers on the wire. Whenever the second hand is in the division marked "1," the subscriber who has that number may be called and no other one will hear the bell. The same is true of No. 2 and so on around the circle. Suppose there are eight subscribers on the wire, each would have seven and a half seconds every minute in which he could be called—deducting a brief interval of silence at the beginning, which is given in order that the calls may not be mixed. As two seconds is ample time for calling a person, it will be seen that there is a good margin allowed. The apparatus is simple. A wire extends from each clock to the central clock, and at each clock is an electric call bell. A single cell in the battery is used, which gives enough electricity to call one bell, but not two. The possibility of the invention turns upon the fact that electricity will take the shortest path possible. When the bells are silent the electric current is passing along a direct line of wire, but when the bells sound the current is passing through several hundred feet of wire coiled at the bell, which closes the circuit when the fingers press the key in the central office. This change in the circuit is made by a simple arrangement in the clock, by which a lever is thrown in one position or another, turning the current into the coil or sending it straight on. If there were enough electricity on, the bells would all ring, but only enough is generated to ring one bell, and that bell is the one which, for the time being, is affected by the electricity in its coil. Since only one coil is affected at one time, only one bell will ring, and when a subscriber hears it he is sure it is for him. Mr. George H. Bliss is the patentee, and the patent is owned by the Signal Telephone Corporation.

THE Silvertown Company are largely manufacturing the improved Leclanché agglomerate cells, in which the porous pot is entirely dispensed with. This form of battery, which was described in the *Telegraphic Journal*, Jan. 1st, 1879, consists of the ordinary Leclanché zinc immersed in sal-ammoniac solution. The negative element is a carbon plate with two agglomerate plates secured to the former by india-rubber bands.

The advantages of the new cell with agglomerate plates are thus enumerated:—

1. A much better use is made of the depolarising power of the manganese, as the reduction of it is more complete than in the porous pot form, where the manganese while being reduced clogs, and prevents the action of the battery long before the whole of the manganese is reduced.

2. In consequence of the readier reduction of the manganese, the carbon plate is more rapidly depolarised than with the porous pot form, and consequently the electromotive force is more sustained.

3. The resistance is *extremely constant*, whatever the electro-chemical work done by the cell may be, and will even tend to decrease in consequence of the formation of chloride of zinc, which is an excellent conductor.

4. The battery is ready for use immediately on charging, because the liquid is brought into direct contact with negative and positive elements.

5. The renewal is exceedingly simple. When the battery becomes exhausted, the depolarising plates, which are joined to the carbon plate, have only to be removed and fresh ones substituted.

6. By avoiding the use of porous pots, the risk of breakage and deterioration is very much lessened, and the cost of renewal considerably reduced.

7. The trouble and cost of maintenance are next to nothing.

THE SAFETY OF RAILWAY PASSENGERS.—The last report of the Madras Railway Company contains an interesting statement respecting the working of Mr. G. K. Winter's patent electrical communication in all the company's trains, and the invention of an apparatus by the same gentleman, which provides a visible danger signal to the driver until the line is blocked. The report states:—"The new electrical communication (Winter's patent) in all trains which carry passengers, and which was introduced at the beginning of the first half-year of 1879, was still further extended during the second half-year, and out of a total train

mileage of mail and day passenger trains of 326,084, this communication was adapted to a mileage of 324,224. The percentage of interruptions, which in the first half-year was 1·43 per cent., was reduced during the second half to 0·57 per cent., a result which may be looked on as most satisfactory. The Madras Railway Company may congratulate itself on having introduced into India, for the safety of passengers, a system almost practically perfect (the invention of one of its own officers), at an initial cost very little in excess of the obsolete and inefficient bell and cord communication, while the cost of its up-keep is actually considerably less." And the Chief Engineer remarks:—"Another question taken up by Mr. Winter, at the instance of the Traffic Manager, was an arrangement by which drivers should have a visible danger signal against them until the line was blocked. This he has successfully accomplished by an apparatus which he has invented for electrically interlocking the block instrument with small semaphore signals on either side of the station. Estimates of the cost have been received, and the question of adopting the invention will be duly considered."—*Ironmonger*.

PRIZES FOR NEW APPLICATIONS OF ELECTRICITY.—*The Journal Officiel de la République Francaise* says:—"A decree dated 7th February, 1852, instituted a prize of 50,000 francs for the best application of the Volta Pile. The first award of this prize was made to M. Ruhmkorff in 1864, for his improved apparatus, which were of great service to industry in general.

"Two later decrees, one dated April 18, 1866, and the other dated 29th November, 1871, threw this prize open to new applications of electricity. A ministerial order dated 26th December, 1876, formed a commission to inquire into this very important branch of physics. As a result of that inquiry the Government propose to award: 1st. 50,000 francs to Mr. Graham Bell, Professor of Vocal Physiology at the Boston University, for the invention of an articulating electro-magnetic telephone. 2nd. 20,000 francs to M. Gramme, instrument-maker, for a magneto-electric machine which produces electricity by motive power. Although the Government propositions exceed those of the special commission which was appointed to inquire into the matter, and whose proposal was to award the only prize to Mr. Graham Bell, while drawing attention to the great merits of three other *savants*, yet the Budget Committee thinks that special notice should also be taken of the great benefits conferred on the public by M. Gramme's inventions, and they therefore strongly recommend that the amounts proposed by the Government should be voted. This second award is so exceptional that the action of the Budget Committee on this occasion 'should not be considered a precedent.'"

ACCORDING to the *Golos*, the Governors of Eastern and Western Siberia have solicited permission for the immediate erection of telegraph lines as far as and along the Chinese frontier. The line solicited by the Governor of Western Siberia is 600 kilometres in length, and he asks for its erection a grant of 100,000 roubles. The length of the line proposed by his colleague of Eastern Siberia is 100 kilometres in length. The object of the latter line is to render communication easier between the troops, and more especially to bring forces readily against the Chinese robbers, the Chunguses. The former line seems entirely intended to do service in the event of Russo-Chinese hostilities.

THE INSTITUTION OF CIVIL ENGINEERS.—A new list of members has just been issued, from which it appears that there are now on the books 1,217 Members, 1,299 Associate Members, 579 Associates, 18 Honorary Members, and 657 Students, together 3,770 of all classes. At the same period last year the numbers of the several classes were 1,148, 1,200, 622, 17, and 591 respectively, making a total of 3,578; showing an increase at the rate of nearly 5½ per cent. During the past session the elections have comprised 2 Honorary Members, 43 Members, 129 Associate Members, and 15 Associates; and 160 Students have been admitted.

THE Antwerp International Bell Telephone Exchange Company now numbers about 200 subscribers.

WE regret to have to announce the death of M. Gaugain, the eminent electrician.

A VERY successful application of the electric light has been exemplified in the lighting of the Orient S.S. *Chimboraso*, which left Gravesend on the 24th for Australia. The installation consists of a Gramme machine generating the current by which seven incandescent lamps using 2 mm. carbons are worked. Four of these are fixed in the main saloon, and the remainder in the steerage, where this mode of lighting is a great desideratum. The lamps are placed in series, but a resistance coil and automatic switch renders each independent from its neighbour. Several spare lamps are carried which can be worked from the same machine. The whole current can also be switched on to a Crompton arc lamp, which is contained in a special lantern fitted with a reflector. This will be used when in port for loading and discharging cargo. The actual illuminating power of the large lamp is 4,000 candles, while each of the small incandescent lights is about 70. The whole of the arrangements have been carried out under the superintendence of Mr. Killingworth Hedges, C.E., the incandescent lamps and Gramme machine being supplied by the British Electric Light Company. The extension of the lighting to the other parts of the ship will be completed on her return.

MR. L. G. TILLOTSON, of the firm of L. G. Tillotson & Co., has just rendered a service which merits the thanks of the telegraphic interest everywhere. Mr. Tillotson, supported by President Eckert and Vice-President Bates, of the American Union Telegraph Company, has brought to light certain evidence which supplies the missing link in the chain of testimony required to prove the worthlessness of the Simpson (or Colgate) claim to a patent for the use of gutta-percha as an insulating substance for wires used for submarine or subaqueous purposes, and in settlement of which large sums have been paid by various companies. The American Union Telegraph Company and Messrs. L. G. Tillotson & Co. have steadily refused all offers for a compromise, believing, as most intelligent telegraphers do, that the patent is invalid. Tillotson & Co. now invite all parties who have paid moneys upon such claim, or against whom such claims are pending, to an examination of the proof in their possession, which has so long slumbered among the Patent Office files, and which, upon the recent trial, was either suppressed or ignored, or at all events was studiously and successfully concealed, as a basis of resistance to said claims.—*The Operator*.

THE Albert Medal of the Society of Arts for 1879 has been presented to Sir William Thomson for his electrical researches, especially those relating to the transmission of telegraphic messages through submarine cables.

Mr. T. G. Ellsworth, manager of the Telephone Exchange at 198, Broadway, of the Metropolitan Telephone and Telegraph Company, has recently invented a new style of switch board for facilitating and simplifying the operation of the lines connected with the Exchange. The invention consists of a board provided with a number of longitudinal bars, used to connect the wires of the different subscribers. When these bars are in use they are turned to indicate that they are occupied, so that the operator may know at a glance which rods are occupied, like an annunciator in an hotel. This switch board stands four feet away from the telephones, the number of which used is by this invention largely reduced, as also are the batteries required. It also enables the Exchange to dispense with the services of a switchman.

Fifteen thousand dollars have been voted by Congress for a statue of Prof. Henry, to be placed in the Smithsonian grounds.

Reviews.

Catalogue of Books and Papers relating to Electricity, Magnetism, the Electric Telegraph, &c., including the RONALDS LIBRARY. Compiled by Sir Francis Ronalds, F.R.S., with a Biographical Memoir. Edited by Alfred J. Frost. London: E. & F. N. Spon, Charing Cross.

This Catalogue has been recently published by the Society of Telegraph Engineers in compliance with the terms of the agreement under which the Society was to possess the valuable library of Sir Francis Ronalds. The magnitude of the work may be judged from the fact that the volume contains over 560 pages. To execute such a task in the satisfactory manner it has been done was by no means an easy matter, and an examination of the Catalogue will satisfy the most critical person that no better man could have been selected for editing the work than Mr. A. J. Frost, the acting librarian of the Society of Telegraph Engineers.

The richness of electrical literature is amply testified by the fact that over 13,000 of books, pamphlets, and other publications on the subject are referred to.

The headings are chiefly the names of the authors of the works, and in cases where any particular interesting facts are contained in any work the substance of the same is referred to.

The volume appropriately commences with a memoir of Sir Francis Ronalds by the Editor.

It is only necessary to add that the general "get up" and printing of the volume are excellent.

Electric Light, its Production and Use, embodying plain directions for the working of Galvanic Batteries, Electric Lamps, and Dynamo-Electric Machines. By J. W. Urquhart, C.E. Edited by F. C. Webb, M.I.C.E. London: Crosby Lockwood & Co.

This volume contains a general account of the means adopted in producing electric light whether by batteries or dynamo-machines. The work contains nearly 300 well-printed pages, and numerous illustrations.

Although theory is wisely steered clear of to a great extent, in many cases where it is introduced the correctness of the statements is decidedly open to question. The practical matter which forms the mass of the volume is, however, generally well chosen and very useful. Voltaic batteries, thermo-electric batteries, magneto-electric generators, electro-magneto electric machines, dynamo-electric machines, electric candles and lamps, measurement of electric light, cost of electric light, are all treated of, and the most recent information on the subjects is worked into the chapters. Altogether the work is a useful one and worth being published.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

(*Continued from page* 218.)

To melt a gram of steel in the electric furnace takes, therefore, $450 \times 15 = 6{,}750$ units, which is within a fraction the heat energy residing within a gram of ordinary coal. It results from this calculation that, by means of the dynamo-electric machine worked by a steam engine, one pound of coal is capable of melting one pound of mild steel. In melting steel in the ordinary air furnace, as practised at Sheffield, three tons of best Durham coke are consumed to melt a ton of mild steel in crucibles, and in working with the Regenerative Gas Furnace, one ton of coal effects the fusion of one ton of steel in crucibles, whilst to produce steel in large masses on the open hearth of this furnace, 12 cwt. of coal suffice to produce one ton of steel. The electric furnace may be therefore considered as being more economical than the ordinary air furnace, and would, barring some incidental losses not included in the calculation, be as regards economy of fuel nearly equal to the Regenerative Gas Furnace.

It has, however, the following advantages in its favour:—1st. That the degree of temperature attainable is theoretically unlimited. 2nd. That fusion is effected in a perfectly neutral atmosphere. 3rd. That the operation can be carried on in a laboratory without much preparation, and under the eye of the operator. 4th. That the limit of heat practically attainable with the use of ordinary refractory materials is very high, because the fusing material is at a higher temperature in the electric furnace than the crucible, whereas in ordinary fusion the temperature of the crucible exceeds that of the material fused within it.

Dr. Siemens next described the results of his experiments on electro-horticulture, the account of which was similar to that given in the *Telegraphic Journal* for April 1st.

For electro-horticulture generally, it is important to employ a lamp with its focus unchangeable in space, and without obstruction to the rays of light falling downward. The novelty of the lamp designed for this purpose consists in the mode of advancing the carbons, which, instead of being effected by clockwork (as has been the case hitherto in constructing regulators), is

effected simply by the force of gravity, or by spring power urging the carbon forward towards the point of meeting, in which forward motion each carbon is checked by a metallic abutment, in the form of a point or edge of copper or other metal of high conductivity, the exact position of which can be regulated by a screw.

This metallic ridge touches the carbons laterally, at a distance of 10 to 15 millimetres from the luminous point, where the temperature of the carbon is sufficient to cause its gradual decomposition in contact with the atmosphere, without being high enough to fuse or injure the metal.

In its application to horticulture, a metallic parabolic reflector of considerable diameter is placed over the luminous centre, in order to reflect downwards all the rays of light and heat which would otherwise pass upward, an arrangement which may be advantageously carried out in these lamps as used for illumination when placed at a considerable elevation above the ground.

Dr. Siemens next alluded to the application of the dynamo-electric current to mechanical propulsion, and explained the electric railway, which was described in the *Telegraphic Journal*, February 15th.

It is a remarkable circumstance in favour of the electric transmission of power, that while the motion of the electro-magnetic or power receiving machine is small, its potential of force is at its maximum, and it is owing to this favourable circumstance that the electric train starts with a remarkable degree of energy. With the increase of motion the accelerating power diminishes until it comes to zero, when the velocity of the magneto or driven machine becomes equal to that of the dynamo or current-producing machine. Between the two limits of rest and maximum velocity the driving power regulates itself according to the velocity of the train; thus, on an ascending gradient the speed of the train diminishes, but the same effect is automatically produced which results from the turning on of more steam in the case of the locomotive engine. When running on the level, the velocity of the train should be such that the magneto-electric machine should make one-half to two-thirds the number of revolutions per minute as the dynamo-electric. When descending, the speed of the magneto-electric machine will be increased, in consequence of the increased velocity of the train, until it exceeds that of the dynamo-electric machine, from which moment the functions of the two machines will be reversed; the machine on the train will become a current generator, and pay back, as it were, its spare power into store, performing at the same time the useful action of a brake in checking further increase in the velocity of the train. If two trains should be placed upon the same pair of rails, the one moving upon an ascending portion, the other upon a descending portion of the same, power will be transmitted through the rails from the latter to the former, which may therefore be considered as connected by means of an invisible rope.

In transmitting the power of a stationary engine to a running train, the proportion of power actually transmitted varies with the resistance to or speed of the train, reaching practically a maximum when the velocity of the machine on the train is about equal to two-thirds that of the current-generating machine, at which time more than 50 per cent. of the power of the stationary engine is actually utilised.

In passing through an adit or tunnel, the entire freedom of smoke from the electro-motor is a matter of great importance; and the administration of the St. Gothard Tunnel contemplate seriously the application of an electro-motor for conveying trains through that gigantic tunnel. Circumstances are in this case highly favourable to the employment of an electro-motor, because at both ends of the tunnel turbines of enormous aggregate power are actually established (having been employed in the operation of boring the tunnel), and all that has to be done is to insulate one of the rails, and to connect dynamo machines of sufficient power to the turbines and to the train itself.

Instead of insulating one of the rails, a copper or other conducting rope may be used to convey the current from the dynamo machine to the train. This conducting rope would rest upon wooden or glass supports, to be picked up by the train in order to pass over one or more contact pulleys, and to be again deposited behind the train. This plan offers the advantage that no insulation of the rails or any of the driving wheels of the train is necessary, both rails fulfilling the office of return circuit. The cost of a copper rope, which in the case of a full-sized railway of great length would be a considerable item of expenditure, would not be heavy in this case. Practice alone can determine which of the two modes of construction is the best, but both can be made efficacious, and the preference will be due to economical or structural considerations.

PHYSICAL SOCIETY.—JUNE 12th.

Dr. HUGGINS, F.R.S., in the Chair.

New Members—Mr. H. B. JUFF, Mr. ADAM HILGER, Mr. C. V. BOYS.

Dr. SHETTLE, of Reading, read a paper on the influence of solar radiation on the earth's rotation. The fact established by Dr. Shettle, that the magnetic energy of a bar magnet acts along spiral lines, has led him to surmise that the energy emanating from the sun and impinging on the earth on the zone of the ecliptic, traverses the earth in a spiral path, and finally emerges at the magnetic poles. The spiral of energy is "right-handed" at one pole, and "left-handed" at the other, like the magnetic force in a magnet, and the electric discharge in Crooke's vacuum tubes. Owing to precession and nutation these spiral paths are constantly changing and producing magnetic variations. He therefore infers that the magnetic poles will complete a cycle corresponding to the period of precession. Dr. Shettle thinks that bodies exhibit magnetic properties in proportion as they change the direction of the energy traversing them, and throw it into the spiral form. Terrestrial magnetism would be due to the solar radiance on this hypothesis. Gravity also would be produced; so, likewise, would the earth's rotation (by a kind of "magnetic whirl"), electricity, tornadoes, cyclones, water-spouts, and whirlwinds. Moreover, this "spiral energy" would seem to operate throughout the whole universe.

Prof. WIEDEMANN, of Liepsic, made a communication on the phenomenon of interference in rays of long path, and showed how the phase of vibration of the atom or molecule emitting the rays influenced the phenomenon. Molecular collisions could operate in preventing interference. From a study of this question he was able to deduce a method of determining the pressure on the surface of the sun and stars. He mentioned that he had found that the temperature of a glowing gas in Geissler's tubes may be under 100° Cent., and therefore the light of the aurora, or of comets, might be accompanied by a low temperature. He had determined that the quantity of heat produced in a gas by the electric discharge was always the same with the same amount of electricity, whether discharged at once or not, and that it increases nearly in proportion to the pressure of the gas. He had also determined that the heat which must be developed by a discharge in hydrogen in order to change the band

spectrum of H into the line spectrum is about 100,000 caloriés for 1 gramme of hydrogen, and hence this might represent the amount of heat necessary to transform the hydrogen molecule into its atoms. Dr. SCHUSTER suggested that Prof. Wiedemann should make a similar experiment with another gas, say nitrogen, as there was a disagreement about the H spectra, and Prof. WIEDEMANN stated that he so intended.

Mr. RIDOUT exhibited a device for amplifying small motions. A small barrel is slung by two threads between the prongs of a metal fork in such a manner that if the fork is bodily carried to and fro the barrel will rotate round its axis. This is simply effected by making each thread, in its passage from one prong to the other, take a few turns round the barrel. To the barrel an index is attached and the fork is then fixed on the body whose minute motion is to be indicated. The translation of the body shifts the fork and rotates the barrel, which in turn deflects the index round the face of a dial, and the magnifying power is expressed by the ratio of the diameter of the barrel to the length of the index. With this apparatus Mr. Ridout exhibited the lengthening of an iron core when magnetised by the passage of the current of 2 Grove's cells through an insulated wire coiled round it. By rivetting a slip of brass to the iron the unequal expansion of brass and iron under heat was also shown, the heat being generated by keeping the current flowing in the coil.

Mr. D. WINSTANLEY exhibited his new radiograph for recording graphically the intensity of solar radiation throughout the day. It consists of a differential thermometer, with one black bulb and a circular stem. The lower part of the stem is filled with mercury, the upper branches with sulphuric acid and water. The tube is mounted on a brass wheel, so that when the black bulb is exposed to the sun's rays the differential motion of the mercury causes the wheel to turn. The wheel carries a light index or marker, which is free to traverse a vertical cylinder covered with paper coated with lampblack, and leaves a white track where its point has scratched off the soot. The radiogram thus produced can be fixed and preserved. Dr. GUTHRIE pointed out the curious "thermal twilight" these radiograms had betrayed to Mr. Winstanley. They show that before sunrise the temperature increases, owing to solar radiation. Moreover, half-an-hour after sunset the index falls and remains till within a few moments of midnight, when it mysteriously rises and sinks again, although the sun is then directly over the opposite hemisphere.

Mr. BAILLIE then gave the results of a study he had made into the theory of the phoneidoscope. He finds that waves simultaneously start from each side of the soap film when the note is sounded, and, meeting in the middle, generate ventral points and notes. The equations of several cases were given by him, and he suggested that photography should be employed to fix the appearance of the figures in order that they might be investigated theoretically.

The following are the final quotations of telegraphs for the 28th ult.—Anglo-American Limited, 61½-62; Do., Preferred, 91½-92½; Ditto, Deferred, 33½-34; Black Sea, Limited, ——; Brazilian Submarine, Limited, 8½-8¾; Cuba, Limited, 9¼-9¾; Cuba, Limited, 10 per cent. Preference, 15½-16½; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 10¾-11¼; Direct United States Cable, Limited, 1877, 11¼-11½; Scrip of Debentures, 102-104; Do., £50 paid, 1-3; Eastern, Limited, 8¼-9¼; Eastern 6 per cent. Preference, 12¼-12¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 102-105; Eastern 5 per cent. Debentures, repayable August, 1887, 103-105; Eastern, 5 per cent., repayable Aug., 1899, 104-106; Eastern Extension, Australasian and China, Limited, 9-9¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 107-110; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 104-106; Ditto, registered, repayable 1900, 104-107; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 101-104, Ditto, ditto, to bearer, 101-104; German Union Telegraph and Trust, 8¾-9¼; Globe Telegraph and Trust, Limited, 5¾-6¼; Globe, 6 per cent. Preference, 12-12½; Great Northern, 9¾-10; Indo-European, Limited, 22½-23½; London Platino-Brazilian, Limited, 3½-4; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10½-11; Reuter's Limited, 9½-10½; Submarine, 235-245; Submarine Scrip, 2¼-2¾; West Coast of America, Limited, 1¼-1½; West India and Panama, Limited, 1¼-1½; Ditto, 6 per cent. First Preference, 7-7½; Ditto, ditto, Second Preference, 6½-7; Western and Brazilian, Limited, 6¾-7; Ditto, 6 per cent. Debentures "A," 100-103; Ditto, ditto, ditto, "B," 100-103; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 33½-34; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3¼-3¾; India Rubber Company, 15-15½; Ditto 6 per cent. Debenture, 105-107.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
May, 1880 ...	*	10,326	2,900	1,334	*	42,963	26,570	19,480	... ...	*	... ...	8,999	3,715
May, 1879 ...	47,910	12,810	3,108	984	15,970	38,371	25,845	18,917	... ...	11,452	... ...	12,430	5,559
Increase	... ...	... ...	... ...	350	... ...	4,592	725	563	... ...	... ...	... ...	... ...	... ...
Decrease	... ..	2,484	248	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	3,431	1,834

* Publication of receipts temporarily suspended.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 179.

LIGHTNING CONDUCTORS.

Now that the summer season is coming on, the usual sensational accounts of accidents caused by thunder storms occupy conspicuous places in both the ordinary daily papers and also in those of a scientific nature. That the damage caused by lightning is very considerable is unquestionable; indeed, the records which already exist make a very fair show, although those of an early date are necessarily of a very imperfect and meagre character. Within the last few years the accounts of the destruction effected, and lives lost, have been very numerous; not that more damage has been effected recently than formerly, but more scientific interest has been taken in the subject, and, consequently, the information gained has been more considerable. Although many scientific men have ventured to give an opinion that protection from lightning need not be made local—that is to say, they consider that, by a judicious distribution of protectors over particular areas of ground, whole tracts of country may have every square foot protected from lightning, yet such a scheme does not seem likely to meet with much support, at least, for some time to come. Local protections of particular buildings, which seem to be more than ordinarily exposed to damage by lightning, is at present all that is considered necessary.

Our foreign neighbours, at a comparatively early date, appointed more than one committee to thoroughly consider the whole question of the protection of buildings from lightning, yet but little, if any, notice seems to have been taken in this country of the reports issued. The independent work of the late Sir William Snow Harris, although very practical, has hardly produced more effect. The fact that two reports were issued by the foreign committee, the latter of the two, in many points, completely cancelling the opinions expressed and laws laid down in the former one, seems to be almost unknown even to the best electrical authorities in this country. One cannot take up even the most recent text books on electrical science without finding the statement still adhered to, that a lightning rod will effectually protect a space contained beneath a cone, the radius of whose base is equal to that of twice the height of the rod. Now, any reader who will take the trouble to examine the second report referred to, will find it most distinctly stated, that the theoretical considerations upon which the theory was founded, and which were accepted as being correct by the first committee, are absolutely without foundation.

We have not the reports before us, but we fancy that the theory that solid rods are not so effectual as an equal weight of metal in the form of a tube, or a flat band, is still adhered to, though the practical data upon which the supposition is founded are devoid of existence. It is somewhat curious that some simple experiments have not been made to clear up this point to the satisfaction of all interested in the subject. In our own opinion we cannot conceive what sufficient reason can be given to warrant the idea that bands or tubes conduct the discharge better than a solid rod. The fact of a static charge existing only on the surface of a body has nothing to do with the question. We trust that the Lightning Protector Conference which was appointed some time ago by several scientific and learned societies, and which has, we believe, held numerous sittings and collected a large mass of evidence, will solve this and other knotty points; though, even if they do so, it will take a long time, we fancy, to make the weight of their authority effectually felt.

THE FIRE ALARM SYSTEM OF THE EXCHANGE TELEGRAPH COMPANY.

THIS system, which is being tried in several of the London streets, is very similar to the American plan which is so extensively adopted on the other side of the Atlantic. The American apparatus in its simplest form consists of a handle contained in a box, at any convenient part of a street. This handle on being drawn forward releases some mechanism in train with a circuit interrupter which makes and breaks the continuity of the line wire by definite periods, corresponding to numerals of the Morse alphabet. At the receiving or fire station a registering self-starting Morse apparatus is placed in circuit with a battery. When the alarm handle is in its normal position the circuit is closed and the Morse armature continually held down. By pulling out the handle and then releasing it the circuit interrupter referred to works and thus indicates on the Morse apparatus the number of the alarm box at which the handle has been pulled. An alarm bell is connected to the Morse to give notice of its working.

The system of the Exchange Telegraph Company is similar to the foregoing, but contains several important improvements which render its action highly efficient and satisfactory.

The general plan of the apparatus is shown by

figs. 1 and 2.—Fig. 1 representing the transmitter, and fig. 2 the receiver.

In fig. 1, H is the alarm handle which is pulled forward to the end of its stroke and then released when an alarm has to be sounded. The end of the stalk of this handle (which slides in guides) has a pin against which the arm, *n*, normally rests. This arm is in gear with the wheel, W, by means of a ratchet wheel and pawl. W is in gear with a train of wheels, which latter are also in gear with the circuit interrupting wheel, C. A strong mainspring has one end connected to the arm, *n*, and the other end to the wheel, W. The arm, *n*, in fact exactly corresponds to the winding-up key of an ordinary train of clock-work, except that it is not rigidly fixed to the winding-up axle but turns loose on it; limit of its stroke, it moves the arm, *n*, a little back, and the pin escapes over the top of *n*, and thus comes back to the position shown in the figure.

The mainspring being thus wound up and free to actuate the train of wheels connected to it, causes the cam wheel, C, to be rotated. In order to check the rate of rotation of C, one of the wheels of the train has on its axle a ratchet wheel and anchor escapement, the movement of this latter, as is well known, being necessarily slow, the required slowness, and also uniformity of motion, is obtained.

Into the teeth of the cam wheel, C, a projection in the lever, *h*, drops; this projection, when C is rotating, causes *h* to oscillate up and down once for each tooth on the cam wheel. Now, if C has all its teeth complete *h* will oscillate continually, and will break

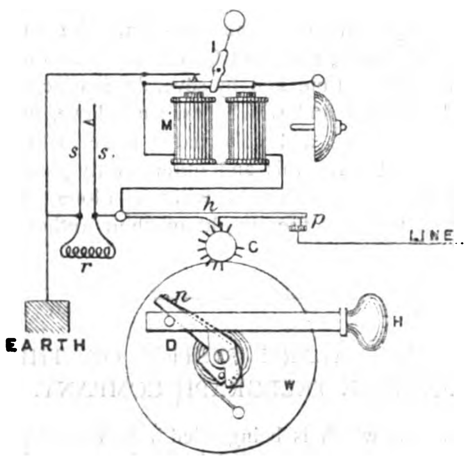


FIG. 1.

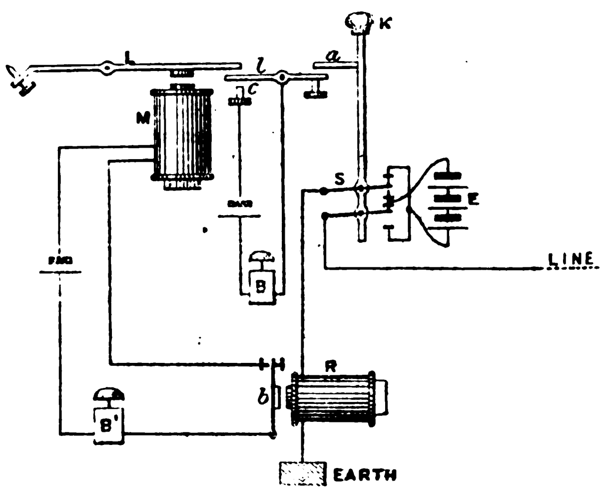


FIG. 2.

it rotates the axle however, when drawn round to the right, by means of a pin fixed on to the axle and against which the lower end of the arm presses. Thus *n* on being drawn forward will act like a key winding up the spring; but on being released will move back, under the influence of a small spring, to the position shown in the figure, thus leaving the mainspring wound up.

Now, on drawing the handle, H, forward, the arm, *n*, is rotated to the right by means of the pin at the end of the handle stalk. When the handle is drawn to its extreme limit, the lever, *n*, escapes from the pin and falls back, thus leaving the mainspring wound up. If the handle, H, is now released, it moves back under the influence of a spring connected to it, and then, when it has come back to the contact at *p*, thus producing contacts corresponding to a series of continuous dots. If, however, some of the teeth be broken away, say, every third tooth, then a series of discontinuous oscillations of *h* will be produced, which will correspond to dots in series of three; that is to say, three dots will be sent, then an interval, then again three dots, and so on.

The contact point, *p*, it will be seen, is connected to "line." The axle of lever, *h*, is connected to one end of the electro-magnet, M_1, of an ordinary trembling bell. The lever is also connected to a straight spring, S_1, which on being pressed forward makes contact with the spring, S. Between S and S_1, a resistance, *r*, is fixed whose value is about equal to that of the electro-magnet, M_1. Finally,

s_1 and the contact spring of the trembling bell are connected to earth.

Between the poles of the electro-magnet, M_1, a steel magnetised tongue with an indicating tablet, I, is placed, the current through the electro-magnet, M_1, will then move the tablet to one side or the other, according to the direction of the current. Normally the position of the tablet is such that it is not visible to the eye, but when a reversal is sent through M_1 it moves over opposite an opening in the case of the transmitter. The whole transmitting apparatus is inclosed in an iron case with a door. This door when shut presses the two springs, s, s_1, together, thus putting the lever, *h*, direct to earth.

We will next consider the receiving portion of the apparatus. R is a relay, whose tongue, *b*, is normally held over by the current against an insulated contact. When the current ceases, *b* moves against its other contact, closing the circuit of the self-starting Morse embosser, M, and its local battery and single stroke bell, B'. At the end of the lever, L, of the Morse is a smaller lever, *l*, which, when its left arm is depressed against contact point *c* by L being pulled down, closes the circuit of the trembling bell, B, and its local battery. S is a reversing switch which is held normally in one position by a spring. To this switch is connected the line battery, E. Thus normally a continuous zinc current flows out to line, the circuit of the battery being complete to earth through the relay, R. K is a small knob fixed to the top of a vertical stalk, which stalk is connected to the switch, S. A small arm, *a*, is fixed to K. This arm projects over the right arm of lever, *l*, so that if K be depressed, *l* will be pushed to the position shown in the figure. The depression of K at the same time actuates the switch and reverses the line current. The action of the whole apparatus will then be as follows :—

The current from E being continually flowing to line, the tongue, *b*, of the relay, R, is held over against its insulated contact; this current flows through the contact point, *p*, of the transmitter (fig. 1), and thence through the lever, *h*, and the two springs, s, s_1 (which are pressed together by the door being shut), to earth.

Now, on opening the door of the apparatus, s, s_1 become separated, and a portion of the current flows through the resistance, *r*, and the other portion through the electro-magnet, M_1, of the trembling bell, which it rings; the tablet, I, is not affected, as it is only held harder over in its normal position.

If the handle, H, is now drawn out and released, the cam wheel, C, is set going, and sends the series of intermittent contacts or sets of dots. As the circuit is partially complete through the resistance, *r*, the intermittent breaks caused by the ringing of the bell, M, do not interrupt the continuity of the circuit.

At the receiving station, the relay, R, is actuated by the intermittent currents, and works the Morse embosser, M, at the same time sounding the single stroke bell, B^1, thus both audible and visual signals are given.

The first movement of the lever, L, depresses the end of lever *l* against the contact point, *c*, and leaves it there. The bell, B, is thus set ringing.

As soon as the alarm is heard and the instrument has ceased working, the person in charge of the instrument depresses the knob, K, thus raising the lever, *l*, off its contact stop, *c*, and stopping the bell, B. The depression of K also actuates the switch, S, thus reversing the line current; the effect of this is to move the indicator, I, over to the position which renders it visible, thus notifying to the sender of the signal that his alarm has been received.

It is evident that any number of transmitters may be joined in the same circuit, each transmitter having its cam wheel teeth arranged in a different way. The earth connection is, of course, only used at the terminal station.

The teeth on the cam wheel are so arranged as only to send "dots," no "dashes" are used, but the dots are arranged in different combinations for different stations. In any case, the sets of signals are repeated three times by the cam wheel.

IMPROVED LIGHTS FOR LIGHTHOUSES.

A SUMMARY of the opinions of the lighthouse authorities on Sir William Thomson's proposals for reform in the present system of lights* has been printed in the *Architect*. It appears that the Committee of Lloyd's, immediately after the letter was published, wrote to the Board of Trade, stating that they considered Sir William Thomson's idea that each lighthouse should furnish some distinctive mark by which it may be recognised, and not confounded with any other, was well worthy of consideration. The Board of Trade accordingly formally brought the subject under the consideration of the authorities having charge of lighthouses in England, Scotland, and Ireland, and in due time reports were returned to the Board.

Messrs. D. and T. Stevenson, the engineers to the Board of Northern Lighthouses, in their report, say that the essential principle of the simple lighthouse characteristics at present in use is that of optical distinction and strongly marked, and, therefore, obvious differences in the periods of light and darkness, while the proposed system consists of intricate and minutely different numerical distinctions in number and order of eclipses crowded into very short periods. The origin of such schemes as that of Professor Babbage and Sir William Thomson is, according to Messrs. Stevenson, an erroneous idea regarding facts which are well established. There is a current and widely diffused, though wholly unfounded, notion that the great cause of shipwrecks is the mistaking of one light for another by the mariner. Mr. Alan Stevenson, in 1851, showed, by statistics of the Scotch coast for four years, that the real cause of shipwrecks at night was not by the mistaking of one light for another, but rather the non-visibility of the lights. Out of 203 shipwrecks occurring in these four years, 133 occurred by night, and in only two of these was it ever alleged that the appearance of the light had not been recognised, and in only one of these two cases were the lights specified that were alleged to have been mistaken for each other, viz., the re-

* *See Telegraphic Journal*, December 15th, 1879, p. 407.

volving light of Inchkeith for the fixed light of the Isle of May. The grand requisite of all sea lights is penetrative power, and not a great variety of characteristics, *i.e.*, by appearances at once appreciable by the eye, or else by broadly marked variations of periods, and not by minute differences exhibited in rapid succession indicative of certain letters of the alphabet, which could only be read by people trained to such a system of telegraphy, or the modification of this system now proposed by Sir William Thomson. Messrs. Stevenson, in conclusion, say that the system of altering all fixed lights to the dot and dash, or Morse alphabet, system would, from the minute differences in characteristics, lead not only to perplexity in the mind of the sailor, but, they fear, to disastrous results; and that such a mode of distinction, though it were free from danger, is uncalled for because unnecessary.

The Elder Brethren of the Trinity House also declined to recommend the adoption of the Morse alphabet as being superior to the methods now in use, or better adapted to the comprehension of every grade of maritime intelligence. It is believed, they say, that if each light of the whole cordon round the coast were taken *seriatim*, there is not one whose identification could not be secured by observations far rougher and less minute than would be required for determining the existence and the sequence of longs and shorts.

The Commissioners of Irish Lights were found to be less inimical to the new system than any other authorities. It would be injudicious, they believe, to adopt the dot and dash system generally, but the group flashing system could be applied with advantage to those lighthouses on the Irish coasts by which the transatlantic vessels shape their courses. It would be of incalculable use to the masters that, on first making land, either in dark or foggy weather, they should have an unmistakable defined light. The Commissioners point out the concurrence of opinion between their scientific adviser, Dr. Tyndall, and Sir William Thomson. Dr. Tyndall said that it would be easy to give every lighthouse supplied by gas so marked a character that a sailor should recognise it with infallible certainty, and in carrying out his recommendations the Commissioners were very early impressed by the extraordinary facility with which, by the simple turning on and off of gas at any required interval, distinctive variations, to almost any extent, might be made in lighthouse lights, without impairing in the slightest degree the great penetrative power of the light itself. So far back as 1867 they applied this system to Wicklow-head, where, by a very simple piece of clockwork, the light is turned on and off, so as to cause a light of ten seconds and an interval of darkness of three seconds' duration; and in 1871 at Minehead the same principle was adopted with fifty seconds light and ten dark. The use of gas in other lighthouses was recommended; and in 1877, with the approbation of the Board of Trade, the Commissioners placed at the new lighthouse at Galley-head a group flashing gas-light, which was lighted in the following year, and is now, they believe, the most striking example in the world of this kind of light, the flashes of the powerful quadriform revolving light at that station being broken into groups, producing an effect of unrivalled individuality. This system of group-flashing is capable of almost endless variations.

Sir William Thomson's other suggestions have been received by the experts with more favour. The advantage of coloured lights at important points is no longer insisted on, and Messrs. Stevenson acknowledge that use of colour is attended with disadvantage, not only to men who are colour blind, but to all mariners in foggy weather, when the white lights acquire a reddish hue, so as to stimulate the effect produced by red shades.—*Journal of the Society of Arts.*

DUPLEX TRANSMISSION WITH TWO RELAYS.

By M. KOVACEVIC, Secretary of the Telegraphic Administration at Agram.

The employment of two relays for duplex transmission has for its object the avoidance of the necessity of establishing equilibrium, an indispensable condition with a single relay, and to give the means of obtaining duplex or diplex transmission without other means than those which are required for ordinary simple working.

It is possible to obtain this object in different ways, and the arrangement depends upon the disposition of the batteries, that is to say, whether like or unlike poles are put to earth at the two stations.

I.

Arrangement of Terminal Stations.

Fig. 1 shows the arrangement to effect duplex working in the first of these two cases, that is to say, when the batteries at the two stations have similar poles to earth, and when, consequently, the poles act against one another. The transmitting keys are of the ordinary kind, having their axes connected to the two relays of each station, and the working contacts to the batteries, of equal power, B, and $B_{,,}$, and to earth.

$R_,$ and $R_{,,}$ are neutral relays, which can, however, be also polarised relays. The relays, $P_,$ and $P_{,,}$ on the contrary, must necessarily be polarised so that they may be acted upon only by the current coming in through the line, W, and not by a current going out to the same.

The figure shows clearly how communication is established with the local batteries, L, and the Morse writers, $M_,$ and $M_{,,}$, by means of the relays, $P_,$ and $R_,$, on the one hand, and the relays, $P_{,,}$ and $R_{,,}$, on the other. The closing of the local batteries and, consequently, the production of signals on the Morse writers can only take place when the armatures of the polarised relays remain in contact with the screws, $u_{,,}$ and when, on the contrary, the levers of the neutral relays are in communication with the lower screws, $v_,$.

The condition indicated in the figure is the state of repose, during which the batteries, of equal power, B, and $B_{,,}$, which communicate with earth by their negative poles, send their positive currents out to the line, W, or produce a neutral effect.

The levers of the neutral relays remain free, and rest in contact with the lower screws, $v_,$, whilst the

armatures of the polarised relays establish communication with the screws, $u_{,}$.

In this case, neither of the Morse writers produce signals, the circuit of the local batteries, L, not being closed.

If the station, I, depresses his key, the positive current of the battery, $B_{,}$, passes through the relay, $R_{,}$, and returns by the point, *a*, to the negative pole, by the axis and the working contact of the lever of the depressed key.

The resistance of this latter path of departure by the point, *a*, which can be formed of short and thick iron wires, being nil, it does not produce any bifurcation, and, consequently, it does not allow any of the current of the battery, $B_{,}$, to pass out to the line, W.

The relay, $R_{,}$, at the station, I, which sends signals, works when its lever is moved away from the screw, *v*, and goes over to the screw, $v_{,}$. The Morse printer, $M_{,}$, produces then its proper signal, if the armature of the polarised relay, P, remains in contact with the screw, $u_{,}$, but such is not the case, as will be seen.

By the fact of the introduction of the battery, $B_{,,}$ with the screw, $v_{,}$, of the relay, $R_{,,}$ when the key is depressed.

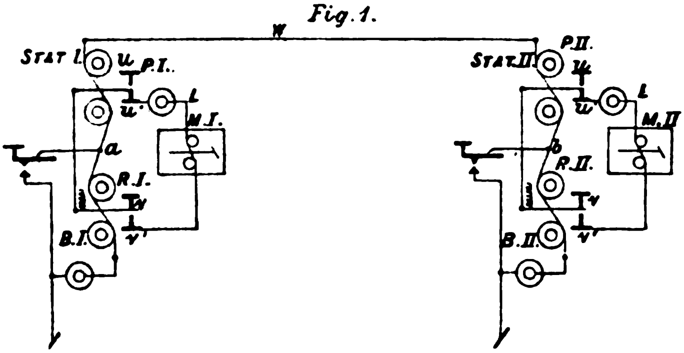
The circuit of the local battery, L, of the station, I, remains open, and consequently, the Morse writer, $M_{,,}$ does not reproduce the signals.

The same thing occurs when station II depresses his key whilst the key of station I remains in its normal position. As, in this case, the current of the battery, $B_{,,}$ is the only one which goes out to line, the relay, $R_{,,}$ comes into action while P, remains inactive. The local battery, L, of the station, I, is then closed, and the Morse writer, $M_{,,}$ reproduces the signal sent out by station II.

When the positive current of the battery, $B_{,}$, which goes out to line, has broken the contact of the armature of the polarised relay, $P_{,,}$, with the screw, $u_{,,}$ the circuit of the local battery, L, of the station II becomes open, although the relay, $R_{,,}$ of that station works by its own current, which finds a closed local circuit from the point, *b*, through the depressed key.

If the two stations depress their keys, the relays $R_{,}$ and $R_{,,}$ are worked by their own currents introduced in the local closed circuit.

Fig. 1.



in the closed local circuit, the battery, $B_{,,}$, of the station, II, is the only one which works to line. Its positive current passes through the two relays, $R_{,,}$ and $P_{,,}$ of the station, II, by the line, W, the polarised relay, $P_{,,}$ of the station, I, from whence it arrives at the point, *a*, by the lever of the key at the station, I, which has been depressed, and by this means goes to earth. The relay, $R_{,,}$, comes into action when its lever leaves the screw, *v*, and makes contact with the screw, $v_{,}$. On the other hand, the polarised relay, $P_{,,}$ does not work, for the northern magnetism being increased in the lower coil and increased in the upper coil, the contact of the armature of the relay with the lower screw, $u_{,,}$ is only made stronger.

The local battery, L, has its circuit closed through the medium of the levers of the two relays, $P_{,,}$ and $R_{,,}$ and thus the Morse writer, $M_{,,}$, reproduces the signal sent out by the station, I.

The positive current of the battery, $B_{,,}$, which goes through the polarised relay, $P_{,,}$ of the station, I, increases the northern magnetism in the upper coil, whilst it decreases it in the lower coil. The armature of this relay leaves then its contact with the screw, $u_{,}$, and that before contact is established

The polarised relays, $P_{,}$ and $P_{,,}$, not being, at this moment, acted upon by any current, their armatures continue resting against their contact screws, *u*; and in consequence, the circuits of the local batteries are closed and the Morse writers respond.

If the station, I, allows his key to return to its normal position, his Morse writer continues to work, the levers of the relays, $R_{,}$ and $P_{,,}$ remaining in contact with the screws, $v_{,}$ and $u_{,}$. On the other hand, the signals sent out by the station, I, cease to be reproduced by the Morse writer, $M_{,,}$, for the contact of the tongue of the relay, P, with the screw, *u*, becomes then interrupted by the current of the battery, $B_{,,}$ coming to line, and the circuit of the local battery, L, becomes opened.

If the station, II, also allows his key to come back to its normal position, the effects of the currents from the batteries, $B_{,}$ and $B_{,,}$, neutralise one another and produce again the state of rest which has been previously referred to, and therefore the station, I, ceases also to reproduce the signals emitted by the corresponding station.

If leakages or changes of resistance occur on the line, the effects of the currents are only to produce partial compensation, and each section of the line

remains influenced by the part of the current which is not compensated for by the current sent out to line by the battery in that particular section.

If the amount of the leakage, &c., is such that the neutral relays, R, and R,,, do not produce signals in their normal condition of affairs, the correct working of the duplex principle is still assured.

If, however, the changes are such that one or other of the neutral relays can produce signals even in their normal condition, then ordinary single working only will be possible for either station, since the case becomes practically one of ordinary working with reversed currents.

In this case the realisation of duplex transmission has, naturally also, reached its extreme limit.

In order to be able to obtain then simple working, and also, consequently, duplex transmission, it will be necessary to regulate one or other of the neutral relays, R, and R,,, or even both of them, so that the tension of their springs is sufficient to cause contact to be re-established by their tongues with the upper screws, *v*.

This regulation, which is easily obtained by means of the counteracting springs, gives the means of obtaining not only ordinary working, but also duplex transmission, and, as can easily be understood, duplex transmission is subject to the same conditions which allow of ordinary single working being effected.

In the state of repose, the position of the tongues of the two polarised relays, P, and P,,, is wholly uninfluenced by leakages; on the contrary, the position of the current remaining in each section of the line simply holds the armatures harder over against the screws, *u*,.

Since the polarised relay of one station, when the key at that station is depressed, should work from the comparatively feeble current which comes in from the line, this relay should be adjusted in such a way that it can be worked by a minimum of power, for it would then not be necessary to re-adjust it after each variation in the strength of the current which is caused by leakages, &c.—*Translated from Annales Télégraphiques.*

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XIII.

THE DUPLEX SYSTEM—(*continued*).

THE actual form of switch for changing from duplex to single working or *vice versâ* is shown by fig. 59. The same form is used both for direct and for relay working.

BATTERIES.

Having in the last twelve articles considered the principal forms of hand-worked instruments employed in the British Postal Telegraph Department, it is now proposed, before proceeding further in the description of the apparatus, to draw attention to the various forms of batteries employed to work the same. At the present time there are three descriptions of batteries in use, viz.: the Daniell, the Bichromate, and the Leclanché; each kind has its special value, which experience has pointed out.

The Daniell which, as is well known, is the oldest description of battery, has been made in several forms, but the essential principle is the same in all. Its great point of utility consists in its being able to give a constant current under all conditions, that is to say, whether it be worked through a high resistance, or on practically short circuit. The electro-motive force, or power of overcoming resistance of the Daniell per cell may, for ordinary purposes, practically be taken as unity or 1.

The Bichromate battery, which is now largely used for telegraphic purposes, is, in principle, an old invention; it has, however, been so modified that its employment, which was discontinued after trial some years ago, has been revived, and with excellent results. The author of these improvements is Mr. John Fuller. The great advantage of the Fuller battery lies in its high electro-motive force, which is practically double that of a Daniell. The internal resistance of the cells, owing to the high conducting power of the fluids used in them, is also very low; this latter fact enables a strong current, under certain conditions, to be given, when batteries of a high resistance will not do so. Although the Bichromate battery is not as constant as the Daniell yet it does not *polarise* to any great extent unless absolutely on short circuit; under the latter condition, the polarisation in 1 minute may be only about 10 per cent., but this latter value varies with the condition of the battery. The Leclanché battery, although it has not the constancy of the Daniell or the power of the Bichromate, is a most valuable battery in cases where a continuous or nearly continuous current is not required, and where the "refreshing" or cleaning of a battery would be a matter of some difficulty and expense, from the fact of its being placed at stations difficult of access, and where the cost of a special journey to set in order a single battery, it may be, would be a heavy item compared with the value of the message work done. The electro-motive force of the Leclanché battery is about 1·6 that of a Daniell, or, in other words, 10 Leclanché cells will give about a similar electro-motive force to 16 Daniells. The battery when not in use does not waste to any appreciable extent, or, in other words, is almost entirely free from "local action;" this is not the case with the Daniell and Bichromate batteries, which, if left to themselves for any considerable length of time will become exhausted, although no current is generated; this local action, however, probably ceases when the batteries are working, that is to say, the whole of the material consumed goes towards producing the current.

If we take a vessel containing a solution of sulphuric acid and water, and place in this a rod or plate of either pure zinc or zinc which has been amalgamated with mercury, then no action or change will be observed on the metal; and, further, if a plate of copper be likewise immersed in the liquid no action or change will take place on either metal provided the two do not touch. If, however, the metals be connected together by a short piece of wire, then bubbles of gas will be copiously given off from the copper or platinum plate, and at the same time the zinc will be attacked by the acid and

FIG. 61.

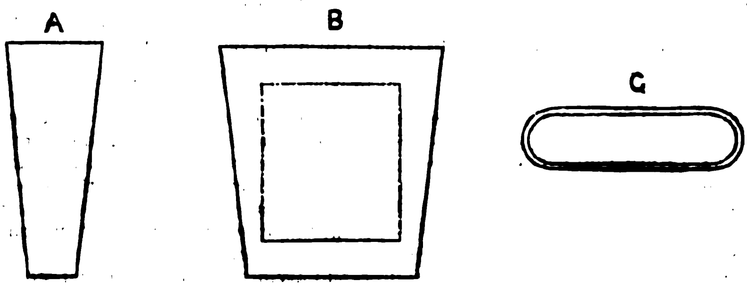


FIG. 59.

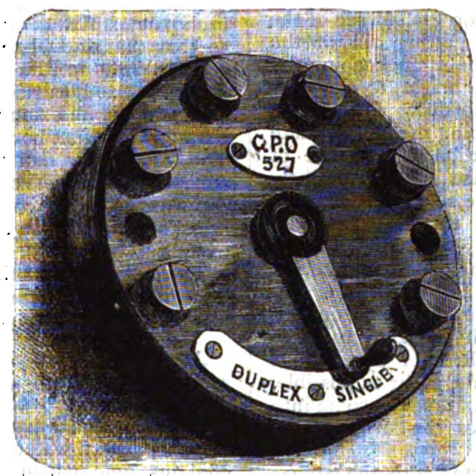
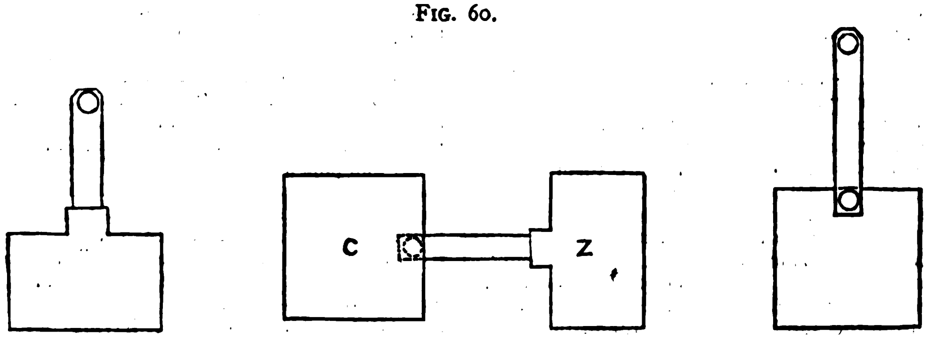


FIG. 60.



Terminal Zinc. Pair of Plates. Terminal Copper.

gradually dissolved, the combination of the zinc with the acid forming the salt sulphate of zinc. This action will continue as long as the plates remain connected together, but will cease immediately the wire joining them is severed. The result of the action on the plates is to generate an electric current in the wire, which current will continue to flow so long as there is material to be consumed, and the solution does not become saturated with the salt formed. To keep the action of the cell up, therefore, it is necessary that the solution be renewed from time to time, and also the zinc be replaced by a fresh one when it is entirely or nearly consumed.

The full action of the battery described will fall off from other causes than that due to the saturating of the sulphuric acid solution; the copper plate becomes coated with bubbles of hydrogen, which adhere to the surface and set up an opposing action.

Daniell's Battery.

To get rid of the effect of the hydrogen, Daniell conceived the idea of causing the gas to throw down a deposit of pure copper on the surface of the copper plate, thus not only getting rid of the *polarising* action but at the same time keeping the surface of the plate clean and bright, so that the flow of the current is not impeded. This object was completely effected by keeping the copper plate immersed in a saturated solution of sulphate of copper, the hydrogen in this case instead of adhering to the plate, decomposed the sulphate of copper, and deposited pure copper on the surface of the former.

As it is necessary that the zinc plate be immersed in the sulphuric acid solution and not in the sulphate of copper, since the latter would be decomposed locally by contact with the zinc, the two liquids are separated from each other by a porous material, which, while it prevents, as far as possible, the mixing of the liquids, allows them to come into actual contact, and thus enables the current to be conducted between them.

The action of a cell constructed with the copper plate in a solution of sulphate of copper contained in a porous vessel, and the zinc in a solution of sulphuric acid, is similar to that of the simple one first described, sulphate of zinc being formed in the sulphuric acid solution and hydrogen on the copper plate, only, as has been pointed out, the gas does not become developed in the form of bubbles.

Although a solution of sulphuric acid placed in the chamber in which the zinc is set increases the power of the battery, *under certain conditions*, by diminishing its internal resistance, yet it causes the sulphate of copper to diffuse rapidly through the porous chamber, and to produce local action on the zinc, an action which amalgamation will not prevent. The practice in telegraph batteries therefore is to charge the zinc chamber with water only. This water, when the battery is once set in action, becomes slightly acidulated by the sulphuric acid set free from the sulphate of copper, and produces sufficient action to develop the full electro-motive force of the battery, though the internal resistance of the latter is higher than would be the case if the acid were used; but the value of this resistance is not so great as to materially affect the strength of the current which the battery is required to give out.

There are three kinds of Daniell's battery at present in common use, viz., the *Ordinary*, the *Chamber*, and the *U. K.* (so-called from its being employed by the United Kingdom Telegraph Company previous to the transfer of that company into the hands of the State).

The Ordinary Sulphate Battery.

This battery consists of a trough 2 ft. long, 4 in. wide, and 5½ in. deep, made of teak, and divided into 10 cells by slate partitions, which fit into grooves ploughed in the sides of the trough; to make these cells watertight they are well coated internally with marine glue, which is a mixture of india-rubber, shellac, and naptha; each cell is then sub-divided into two equal compartments by a porous partition of white unglazed porcelain, ¼ in. thick; these partitions are fixed in position whilst the coating of marine glue is hot. The zinc and plates for the cells are 3½ in. wide and 2 in. deep; these are connected by a copper strap to a plate of sheet copper, 3 in. square; the copper strap of each pair of plates is bent over the slate partition, so that the zinc plate hangs in one cell and the copper plate in the contiguous cell. A pair of plates is fixed astride of each slate division, so that a copper and zinc plate face one another with a porous partition between throughout the trough. The last copper and the last zinc plate are each connected to brass binding screws or terminals, the copper plate being connected to the left-hand terminal and the zinc to the right-hand terminal of the trough.

The exact form of the battery plates will be seen from fig. 60.

To charge the Battery.

About 3 oz. of sulphate of copper crystals, which must be in lumps of about the size of hazel nuts, are placed in the compartments containing the copper plates, and the former are then filled with *soft* water (hard water should never be used, as it contains lime which incrusts the zincs and the porous partitions, and stops the action of the battery) up to a level with the top of the zinc plates. A little time must then be allowed for the liquid to thoroughly saturate the porous divisions, and drive out the air contained in the pores. When this process is observed to be complete the compartments containing the zinc plates must be filled up to within about a quarter of an inch of the top of the zinc plates. As the porous plates in absorbing the solution contained in the copper compartments will have reduced the level of the liquid these compartments must be re-filled so as to make the level the same in all the compartments. When batteries are charged in this way they get into proper action much quicker than would be the case if all the compartments were filled simultaneously.

The battery so charged will be found in thorough working order at the end of about 24 hours, a portion of the sulphate of copper having become dissolved in the compartment in which it is placed, and sufficient having passed through the porous partition into the zinc chamber to start the chemical action.

If the battery is required for immediate use it

may be started at once into good action by placing a weak solution of sulphate of zinc in the zinc compartment. It is a common practice to obtain this solution by taking a portion of the liquid from the zinc chambers of batteries which are in full action, and placing it in the cells, which are then filled up with water. Care must be taken that the zinc plates of the battery do not touch the porous partitions, as this causes metallic copper to become deposited on them.

The solution in the zinc cell must never be allowed to become saturated with sulphate of zinc, as this stops the action of the battery by causing crystals to form on the zinc plate. Crystals are also liable to form on the tops of the plates and edges of the trough; these should be wiped off when they form, by means of a damp cloth, otherwise the liquid in the cells will be drawn off by the capillary action of the salt.

Some crystals of sulphate of copper must always be kept in the copper cell, otherwise the action of the battery will cease, owing to zinc instead of copper being deposited on the copper plates. When a sulphate battery is cleaned, the zinc plates should be scraped to remove the deposit of copper which always adheres to them; the plates need not be removed for this purpose, as only the side of the zinc facing the porous partition gives action in the battery.

Owing to the action of the current, and from other causes, the liquids in the cells often become unequal in level, the solution filling one cell completely, and leaving the neighbouring one half empty; an occasional syringing out is necessary to prevent this.

Besides being tended constantly, the battery must be thoroughly cleaned every two or three months, according to the work it has been doing. The solution in the zinc cell is first drawn off by a syringe, and placed in a jar in which a few scraps of zinc are placed, to throw down any copper which may be contained in the solution; this solution is used for recharging the batteries after they are cleaned. The liquid in the copper cell is similarly drawn off and kept. The crystals of sulphate of copper are next removed, and then the plates are taken out, and well scraped and cleaned, the mud removed being kept for sale. The porous partitions are then cleared of copper, and the cells finally well washed out with clean water.

The "Ordinary" sulphate battery, although it is at the present time extensively used, has the great disadvantage that, if any of the porous partitions become broken, they cannot be replaced without the whole battery being dismantled. It is difficult also to make the porous partitions sufficiently strong without making their resistance high. For these, and other reasons, this form of battery is now practically obsolete, and is being superseded as quickly as possible by another pattern.

THE CHAMBER BATTERY.

This form of battery, like the foregoing, is also extensively used. The cells are made in pairs, and consist, first, of a square chamber of white glazed porcelain, 5 inches square, and 5¾ inches deep; this chamber is divided into cells by a partition of the same material. Into each cell is placed a porous earthenware pot of the form shown in side, front, and top view, by A, B, C, fig. 61, respectively. The top, sides, and bottom of these pots are dipped in hot paraffin wax, as shown by the dotted lines in A; the back is also similarly coated, thus only the portion of the pot opposite the zinc plate is left porous. This prevents the diffusion of the sulphate of copper through the pores into the sulphate of zinc solution, except at the part opposite the zinc, where it cannot be prevented. Recently ozokerit has been used in the place of paraffin, and with success, as it is not so brittle as the latter substance.

In this porous pot the sulphate of copper and the copper plate are placed. The size and arrangement of the plates, and the mode of fitting, charging, and maintaining the battery, are precisely the same as in the "Ordinary" battery.

Five of the porcelain chambers, forming ten cells in all, are placed in a wooden box, 2 feet 2 inches long, without partitions. In many places this box is dispensed with, and the chambers are simply ranged on shelves or racks in the battery room, and are covered over by hinged covers forming part of the rack itself.

As compared with the "Ordinary," the "Chamber" battery offers extra facilities for cleaning and repairing; imperfect cells and porous pots can obviously be replaced with the greatest facility.

Notes.

A SOMEWHAT curious communication has been recently made to the Academy of Sciences, Vienna, by M. Exner. This gentleman announces that if a bismuth and antimony thermo-pile pair be plunged into a gas which has no chemical action upon either of the metals, then heat applied at the junction will not cause a current to be generated. If also two copper bars be joined together, and one be so protected that it cannot be acted upon, then if the pair be plunged into chlorine gas, which attacks copper, a current will be generated on applying heat to the junction; this is not the case if the two bars be both protected or unprotected.

THE SCANDINAVIAN PATENT OFFICE.—The following resolutions have been passed by the French and Danish Governments, dated 7th April, 1880, and likewise by the Government of the Kingdom of Italy, March 3rd, 1880, relative to the registration of trade marks and designs:—France and Denmark.—1st. "The Danes in France and the French in Denmark, shall enjoy, as regards the registration of trade marks and designs, the same rights and protection as the subjects of these respective countries themselves." 2nd. "Subjects of either of these two countries, desiring to secure to themselves the registration and sole right of their trade marks and designs in either or both of these two States, are bound to conform to the rules and formalities prescribed by law and in existence in these two contracting States." 3rd. "The resolutions explained in the above two articles are equally applicable to the trade marks and designs of any kind or nature whatsoever." 4th. "This arrangement, as above described, shall be executory immediately after its promulgation in the two countries, and shall continue in force for the term of one year after the rescinding of the resolution by one or other of the contracting parties." Italy.—The Court of Cassation of Turin, under date of March 3rd, 1880, has

sanctioned the following resolutions in regard to the law of the 30th August, 1868, concerning the registration of trade marks and designs, which is applicable and favourable to all foreign manufacturers. 1st. "When a mark or sign presents a similar character to any other symbolical characteristic, for example, the name and signature of the inventor, and the name of the place from whence the goods arrive, and to which the marks or signs are attached. A foreigner, who lawfully uses the same mark or sign in his own country, may also have the exclusive right to use the same in the Kingdom of Italy by conforming himself to the prescribed law, passed the 30th of August, 1868, regarding the registration of trade marks and designs." 2nd. "That any use of such a mark or sign, or the same being published and promulgated in the Kingdom of Italy previous to the obtaining of the necessary certificate of protection, shall be considered as a violation of the law, and no exclusive right to use any mark or sign will be guaranteed after such mark or sign has thus fallen into public hands." The result of the above resolution being that all foreign manufacturers or merchants who first register in Italy their distinctive trade mark or sign will be able to obtain the protection of the same by law, and a guarantee against any infringement whatsoever.

TELEGRAPH BUSINESS AT CHICAGO DURING THE REPUBLICAN CONVENTION.—The political telegraphing, especially during presidential elections, has become an important item in the aggregate of telegraph business done. The recent prolonged and excited National Convention of the Republican party at Chicago, gave active employment to all the telegraphic facilities which could be supplied, the amount of business done by the telegraph companies during the session of the Convention, and for two or three days previous to its assembling, greatly surpassing that of any similar gathering in the past. The Western Union Telegraph Company worked some fifty circuits from the Exposition Building, where the Convention held its sittings, all of which were kept busily occupied. On these circuits the company sent an aggregate of 300,000 words of matter containing the most important part of the proceedings, which were bulletined at about 6,000 of the company's offices for the benefit of the public, free of cost. In addition, there was an average of nearly 400,000 words sent daily to the press, or a total of 3,049,556 words of press reports, sent from May 29 to June 8, inclusive. Besides this there were 225,468 private messages sent, making a total of 7,858,916 words. At the Illinois Republican State Convention, which preceded the National Convention, and in which the interest was unusual and the excitement attending it very great, the work done by the Western Union Company was very heavy and very promptly and satisfactorily performed. The telegraph labour commenced May 16 and ended on May 22, thus lasting an entire week. The Convention proper was in session three days. The week's record shows the following handsome results:

	Words.
Special and associated press matter sent ...	215,925
Press matter received for delivery to the local press	38,208
Total press matter	254,133

Journal of the Telegraph.

Les Mondes states that M. Tommasi has recently been effecting improvements in his relay with the view to make it practically workable on the Hughes instrument through a submarine cable. The instrument has been made to work through a resistance considerably higher than that of the transatlantic cables, an achievement which is made the most of, but which in no way proves that the effect of inductive retardation will not cause interference.

M. BECQUEREL finds that in the cases of the diamagnetic gases, protoxide of nitrogen, carbonic acid, nitrogen, and olefiant gas, the amount of magneto-rotatory polarisation which rays of light undergo in passing through the same varies nearly in the inverse ratio of the square of the wave lengths as for non-magnetic bodies. Oxygen, a magnetic gas, acts differently, for red rays it gives a rotation which is a little above the green rays; in the case of the diamagnetic gases the reverse is the case, the rotations for green as compared with red being as 10 to 15.

THE Society of Slate Quarriers of Angers are adopting the electric light in their subterranean chambers in the place of gas. The plant comprises a 16 horse-power engine, 6 continuous circuit Gramme machines, a seven strand cable copper conductor 350 metres in length; the lamps are of the Serrin type. Taking each lamp as equal to 300 Carcel burners, the cost of lighting per hour is estimated at ·0037fr. for electricity and ·034fr. for gas.

THE Council of the Society of Arts have addressed a memorial to the Postmaster-General, asking him to reduce the tariff for inland telegrams by fixing the limit of charge at sixpence instead of a shilling, as at present. The memorial points out that, as regards cheapness of telegrams, England is behind several continental nations, and refers to the curious anomaly that a telegram can be sent for less money from any part of the United Kingdon to Belgium, than from one part of London to another. Between England and Belgium the charge for telegraphic messages is twopence a word, and, consequently, a telegram of four words (the sender's name, the receiver's name, the receiver's address, and a word for the message) can be sent for eightpence. Sufficient time has not elapsed since the sending in of the memorial to admit of a reply being received.

RESISTANCE OF MAGNETO-ELECTRIC MACHINES.—A paper was read by M. Carnellas on the 7th inst, before the Académie des Sciences, on the direct measurement of the interior resistance of magneto-electric machines in motion. The induction of the electro-magnets and the metallic cheeks is obviated by rotating the (Gramme) ring mounted carefully with its brushes on wooden supports, and the effects of terrestrial induction are avoided by opposing to each other these effects in two similar Gramme rings, mobile under the same conditions, with axles parallel. The ring (at rest or rotating) is made the fourth side of a Wheatstone bridge formed by Siemens' universal galvanometer. The resistance of the ring in motion (450 turns per minute) shows an increase of 25 per cent. on that of the ring at rest.

THE Bell Telephone Company of Canada held its first meeting at Toronto on Tuesday, June 1st. The company has purchased all the exchanges and business in Canada owned by the Dominion Telegraph Company, and is trying to purchase the Montreal Telegraph Company's telephone business. It has also purchased all the independent exchanges, including the Toronto Company.

THE PNEUMATIC TELEGRAPH IN PARIS.—Since the reduction of the charge for a single message by the pneumatic system, that is to say, since the first day of

last month, the number of messages sent has more than doubled. From some statistics published in Paris it appears that when a message has only to traverse a single section of the tube eight minutes are only expended, including the necessary office business appertaining to the message; for each section after the first five minutes more must be added, and as the great majority of messages pass through four sections the average time per message is equal to twenty-five minutes. There are, however, distances of eleven sections, and one, that from the Bastille to the Place du Trône, of twelve sections, and in the last case the journey occupies sixty-three minutes. Measures are now being taken to shorten, if possible, the time occupied by the passage of the cards through the tubes.

At a recent sitting of the Académie des Sciences M. Reynier exhibited an improved voltaic battery. The new arrangement consists of amalgamated zinc in a solution of caustic soda, and a copper plate in sulphate of copper, the two solutions being separated by a rectangular vessel of several thicknesses of parchment paper. The electro-motive force of the new element is 1·3 to 1·5 volts, according to the concentration of the liquid. The couple can be regenerated by passing through it the current from a dynamo machine.

At the same meeting of the Académie M. Ader presented a paper in which he gave the results of experiments proving that all bars of magnetic nature submitted to a mechanical action of compression, torsion, or traction, tend to recover their original molecular arrangement under influence of the magnetising current.

The new Russian imperial yatch *Livadia* has been fitted up with eight Jablochkoff candles, under the superintendence of Lieutenant Rimsky-Korsakoff of the Russian Imperial navy. No less than sixty Jablochkoff candles will be ultimately in use.

At Halifax, N.S., May 29, while divers were at work at Cole Harbour dike, a storm came upon them, and the lightning striking an air pump passed down to a diver under the water. When brought up he was insensible, but his injuries are not serious.

It is said that the Western Union has appointed a special committee to equalise rates. Formerly reductions were made only to the large cities, and it is now proposed to equalise them, so that smaller and interior towns shall derive a proportionate benefit from each reduction. President Green recently said that the business of the company was never so good as now, and that there was an average of 4,000 more messages a day being received than during the same period last year.

Puck, the American *Punch*, thus expresses its opinion of Mr. Edison:—"Edison is not a humbug. Far from it. He is a man of a type common enough in this country—a smart, persevering, sanguine, ignorant, show-off American. He can do a great deal, and he thinks he can do everything. As a matter of fact, he is so smart that he is the tool of the first scamp that comes along. He would invent to-morrow, in perfect good faith, a three-legged stool. He would let speculators organise a stock company to float that three-legged stool. Then, when he found that three-legged stools were in common use before he was born, he would cheerfully go to work to invent something else, honestly unconscious of having done any mischief. That is just his position to-day. He has fussed and fumed over his electric light until he has made for himself every variety of failure that other men had made before him. Meanwhile, his Wall Street friends have put stock on the market, sold it at a high figure, and are now stowing away the difference between said figure and the present, which is somewhere along in the latitude of the Keely motor quotations. We acquit him of any complicity in all this. Mr. T. A. Edison probably hasn't a very delicate sense of commercial etiquette, but he is neither incompetent nor dishonest. However, if all this nonsense is being turned to bad account by dishonest people, it is Mr. Edison's business to protect the public from any wrong done them under cover of his reputation. And we fear there will some day be an exposure and an explosion that will make Mr. Edison feel particularly miserable. Let him see to it, that such misery is not deepened by remorse."

A fatal accident occurred at a fire in Manchester through a fire-escape coming in contact with a telegraph wire attached to a chimney; the latter was pulled down and a falling portion killed a woman. It appeared at the inquest that the wire was one erected by a private firm, and was 22ft. from the ground. The jury returned a verdict of "Accidental death," and added a recommendation to the effect that, in consequence of this accident and the possibility of other accidents, all wires, whether private or public, should be put up at a height of not less than 35ft. from the ground.

A new Russian Electrical Journal, entitled *l'Electricité*, will make its appearance this month; it will be issued fortnightly, and edited by the sixth section of the Société Impériale Technique Russe, at St. Petersburg. The staff of the Journal includes several distinguished names. We wish our new contemporary every success.

The present month also witnesses another addition to scientific literature. Under the excellent title of *Science*, a new American weekly periodical published its first number on July 3rd. It is difficult to judge from a first issue what success the new attempt will have, but the list of scientists who have promised their help augurs well for the future. The new production is of a somwhat similar class and uniform in size with our contemporary, *Nature*.

The Silvertown Telegraph Works are now manufacturing an improved Poggendorff Bichromate Battery. The peculiarity of the new battery consists in the use of an improved bichromate compound, and also of a new exciting powder, which replaces the sulphuric acid generally used in this form of battery. The results obtained by the employment of these compounds is stated to be far superior to those derived from the use of other mixtures.

Dr. Stone recently exhibited before the Physical Society an electro-magnet wound with the best charcoal iron wire $\frac{1}{4}$th in. in diameter, instead of the usual copper wire. The wires are wound on it in parallel circuits, and joined up for "quantity". It is stated that the lifting power of the magnet is four times as great as what would be obtained by the use of copper wire.

The Russian company to work the Jablochkoff patent in Russia, with a capital of 5,000,000 roubles, and with the inventor as promoter, is, so says the paper *Molva*, not a success. M. Jablochkoff advertises that the money will be returned to the subscribers.

Review.

A Physical Treatise on Electricity and Magnetism. By J. E. H. GORDON, B.A. Camb., Assistant Secretary of the British Association. Two Vols. London: Sampson Low, Marston, Searle, and Rivington.

THE number of experiments that are being continually made by some of the most well known physicists, both English and foreign, is legion, and the apparatus for conducting the researches is often of a complicated and costly character. The records of the work done are decidedly voluminous and complete; but from this very fact it is difficult even for the most studious physicist to know what amount of discovery has taken place in any particular subject. Many branches of physical science have had the records of experiments made in those branches well described and illustrated in a concise form, but hitherto the records of electrical science have not been put into such a shape as has enabled workers to know what has been done. Mr. Gordon's new work is a step in the right direction to partially supply this want.

Considering that the experimental work has been carried on with elaborate and costly apparatus, it must be evident that a full description of the work executed, to be successful, must be carried out regardless of expense in illustration. This Mr. Gordon has done, and done very successfully, and he is to be congratulated upon the favour which his book has already met with. Over 250 illustrations—a very large number of which are whole page engravings, thoroughly well executed—in the two volumes show that neither pains nor money has been spared to make the undertaking as complete an exposition of the subjects treated on as possible.

The author states in the preface that "My object in this treatise has been to give a complete account of such portions of electrical science as I am acquainted with, and, at the same time, to regard them from a physical as distinguished from a mathematical point of view." "In order that the book may be more useful, I have entered very fully into the actual experimental details of most of the investigations mentioned, partly in order that any one wishing to continue the experimental investigation of the subject may find in the book accounts of what has already been done, and partly that students may see that electrical phenomena have a real existence, and are not merely abstractions or results of mathematical analysis."

In the first part of vol. 1 electro-statics are dealt with. In speaking of the "earth connection" it is pointed out that "Since in a body of small dimensions an induced charge on one end causes an equal but opposite charge to be induced on the further end, that if the body be connected to 'earth' the whole world becomes part of the conductor, the 'far end' being somewhere in Australia." This we consider to be quite a correct idea, though it is disputed by many. It is difficult to conceive that because a body is of very large dimensions it should not be subject to the same law which holds good for a smaller, the question is one of degree only. It is quite true that the conditions are such with a body of large dimensions that they may be *considered* as following a different law; but it is not true therefore to say that the theories in the two cases are not identical.

In dealing with problems of electro-statics for purposes of calculation, it is always advisable to have a clear notion of the nature of the thing with which we have to deal, although we may not know exactly what it is. If we attempt to explain what electricity is we may only confuse ourselves, especially if we bring the ideas into play when dealing with electrical problems. Mr. Gordon on this point says, "For purposes of calculation, electricity of either kind may be treated precisely as if it was a material or compressible fluid. It, however, differs from a fluid in the fact that equal quantities of the two kinds neutralise each other."

The transmission of electric force through space Mr. Gordon considers to be effected by a *strain* or distortion of the medium which fills the space between the electrified bodies. In the case of interplanetary space the ether is the medium, this medium having in itself no electrical properties. In speaking of lightning conductors, a proof, by Professor Ayrton, is given of the reason why pointed conductors enable a discharge to take place freely.

The idea of potential, which it is so hard to define clearly, is dealt with in the usual manner; that is to say, no attempt is made to define what potential is, but the way in which the term is used is pointed out. Passing on to electrometers, we find the various kinds of these instruments very fully and clearly illustrated, though instructions in the use of the apparatus are not given.

Chapter XI., on specific inductive capacity, is very full, this subject being, we believe, a favourite one with the author, whose own experiments are naturally dealt with at length. In these experiments, the substance whose inductive capacity is to be measured is not subjected to a continual charge, but to a rapid series of reversals, so as to prevent, it is thought, absorption; the whole apparatus used is very elaborate. The correctness of the method adopted is, we think, open to question, or, rather, we doubt whether greater accuracy is insured by it than by the ordinary methods. Professors Ayrton and Perry's investigations on the specific inductive capacities of gases are fully described, the conclusions arrived at being that gases differ very little in this quality, though differences do exist.

Part II. deals with magnetism, and for the first time, we believe, the beautiful instruments used at the Kew Observatory are described and illustrated. The description of the self-recording magnetometer is especially interesting.

Part III. describes the Voltaic battery. Considering the numerous theories that have been put forward relative to the protecting action of mercury on zinc, we look with interest to see if Mr. Gordon expresses an opinion on the subject. We find that "It probably acts by coating the zinc and particles of iron alike with one and the same metal," an explanation which we fail to see is any explanation at all.

Mr. Warren De la Rue's battery is fully described. This battery is perhaps one of the best forms possible for laboratory work. It is very compact and cleanly, and, for this reason, is becoming very extensively used for cable testing.

With reference to Grove's battery, it is stated "There is no economy in purchasing small cells, as

with them the acids can seldom be used more than once, whereas, with large ones, they can be used four or five times. 'Quart' cells, with platinums 6 inches by 3 inches, are the best size." This is a useful scrap of information.

The chapter on the Wheatstone bridge contains excellent illustrations of the various forms of apparatus used in connection with it, but in speaking of the "metre bridge," or, as Mr. Gordon calls it, the "sliding bridge," it is stated that it is not susceptible of great accuracy, a statement devoid of fact, as it is the only form of bridge with which accurate measurements of low resistances can be made.

To those who wish for a clear explanation of the adjustment of the B. A. units, we would commend Chapter XXVI., as the explanations are very full and clear.

Part III., vol. 2, deals with electro-kinetics. The chapters in this part are on "Standard Coils," "Diamagnetism and Magno-crystallic action," "The Determination of Equi-potential Lines and Surfaces and Lines of Flow;" these latter experiments, which are very interesting, were made by Professor W. G. Adams, the subject being treated purely experimentally. The chapters on the induction coil and the experiments made with it are very fully illustrated, the beautiful experiments of Messrs. Warren De la Rue and Spottiswoode being shown by coloured plates. Mr. Crooke's experiments are also fully described, indeed are reprinted *verbatim* from the lecture delivered before the British Association in August, 1879.

Messrs. Perry and Ayrton's experiments on contact electricity are also merely reprints from papers by the authors. Concerning this question, it appears to us that the phenomenon of so-called polarisation in batteries has never been explained satisfactorily. The electromotive forces or potentials produced when a single metal is placed in contact with an electrolyte is stated to be definite; now polarisation is said to be due to the development of hydrogen on the surface of the negative element; this produces an opposing electromotive force and reduces the effect. If, then, the electromotive force produced is definite, why does not the potential at the battery poles go down with a jump, as it were, and not go on gradually decreasing as is actually the case? It has been explained that the cause is due to the hydrogen becoming more and more developed, an explanation which is no explanation at all. The hydrogen does become developed, and the electromotive force decreases as this takes place, but why it should do so is not explained. The effect of an opposing electromotive force in a circuit is definite, no matter whether this be produced by a very small battery or by a number of the latter all connected together for quantity. If we consider each bubble of the hydrogen of polarisation to be similar in effect to a small battery, then the first bubble should reduce the electromotive force a step, and all succeeding bubbles should neither increase or decrease this effect.

Perhaps the most novel matter in Mr. Gordon's book is that contained in Part IV., in which the relations between electricity and light or electro-optics are dealt with. The experiments on this subject are highly interesting, and the author has himself verified the results of a number of the researches.

Proceedings of Societies.

PHYSICAL SOCIETY.—JUNE 26th.

Prof. W. G. ADAMS in the Chair.

MR. C. V. BOYS read a paper by Professor GUTHRIE and himself on the measurement of the conductivity of liquids by means of magneto-electric induction. The liquid is suspended in a glass vessel by a fine iron wire in the centre of a cylindrical electro-magnet, formed of two semi-circular parts. This electro-magnet is rotated at a velocity not exceeding 3,000 turns per minute, and the liquid being drawn round in the direction of rotation the wire is subjected to torsion which, under correction for certain errors, is proportional to the resistance of the liquid. The torsion is observed by means of a scale and microscope. The results plotted in a curve agree very closely with those of Kohlrausch obtained by alternate currents, and Dr. Guthrie thinks that they are probably more correct and trustworthy than Kohlrausch's, for the method would seem to be superior and the curve contains fewer eccentric points than his.

Dr. GLADSTONE read a paper on the "Refraction Equivalents of Isomeric Bodies," in which he described the present state of the subject and his own contributions to it. He showed that the refractive power of bodies over light was of great importance to chemists, since it depended on their essential structure.

Dr. HUGGINS described his latest results of star spectra, and illustrated his remarks by photographic spectra, taken by his improved method. From these it appears that certain stars, such as Vega, give a complete spectrum of hydrogen. Others, more yellowish in colour, show a thinning of these lines, such as Sirius, N. Ursæ Majores. Others show the intrusion of more refrangible lines, for example, Arcturus, A. Aquila, L. Virginius, while Capella gives a complex spectrum like that of the sun. Dr. Huggins also showed a spectrum of the flame of a spirit lamp, which presented a strong group of lines at s, and he considered it to represent the light emitted by the molecules of water. He further observed that the spectrum offered a highly sensitive test of the presence of carbon.

Mr. LIVEING exhibited a new fire-damp indicator, capable of detecting a quarter per cent. of marsh gas in air. It is based on the fact that an incandescent body shows more brilliantly in proportion to the amount of marsh gas in the air, and consists of two fine platinum wires kept incandescent by a magneto-electric current sent through them in one circuit. One wire is excluded from the fire-damp, the other is exposed to it, and the relative intensities of the two glowing wires is compared by a photometric screen placed between them and adjustable to a position between them at which the reflections of the wires on the screen are of equal intensity. The position of the screen relatively to the wires is given by a scale, and measures the proportion of fire-damp in the air. This contrivance is more advantageous than the safety lamp, which only indicates two per cent. of marsh gas.

Dr. STONE explained a new vacuum shunt for induction currents, devised by himself and Dr. KEILER. It consists of a mercury barometer tube with Torricellian vacuum and a movable cistern suspended by a cord over a pulley and supported by a counterpoise. By raising or lowering the cistern (which is connected to the tube by an india-rubber pipe) the mercury column is also raised or lowered, and the length of the vacuum, that is, the resistance of the shunt, altered.

Mr. MACFARLANE GRAY read a paper on "Specific Heats calculated from Eutropy." The author arrives at some remarkable results, which will be found in his

paper in the Proceedings of the Society. He also explained a new graphic method of representing eutropy.

Mr. Clark communicated a paper on the behaviour of liquids and gases near their critical temperature.

Mr. Winstanley exhibited two new varieties of air thermometers and a thermograph, actuated by an air thermometer, on the principle of his radiograph, exhibited at last meeting. The first thermometer consists of a U tube, with terminal bulbs, and the left leg of much finer bore than the right. Mercury is in the right leg, sulphuric acid surmounted with air in the left. The apparatus is a barometer to the air inside the left bulb, and a thermometer to that outside. A similar combination of an air thermometer and an aneroid barometer constitutes the second instrument. The expansion or contraction of the air in the stem by external temperature expands or compresses a small aneroid chamber in the bulb.

Mr. Gee and Mr. Stroud made a communication on a modification of Bunsen's calorimeter, which will be found in the Proceedings of the Society. The meeting then adjourned till the winter session commences.

New Patents—1880.

2387. "Improvements in electric telegraphs and in apparatus connected therewith." Sir C. T. Bright. Dated June 12.

2390. "Improvements in and connected with the working of railway signalling apparatus." G. K. Winter. (Partly communicated by J. Craik.) Dated June 12.

2392. "Improvements in and relating to the mariner's compass and in appliances for adjusting and correcting the same." D. McGregor. Dated June 12.

2418. "Transmitters for telephones or vocal sound telegraphs." R. M. Lockwood and S. H. Bartlett. Dated June 15. *(Complete.)*

2432. "Improvements in or relating to ship's binnacles and lamps, part of which invention is applicable to other purposes." J. M. Sim. Dated June 16.

2433. "Apparatus for moving and locking railway points and signals." R. Hill and D. Marlor. Dated June 16.

2444. "Improvements in fog alarm signals for railways and in attaching fog or alarm signals to the rails of railways." T. Jenkins and W. Price. Dated June 16.

2445. "Improvements in floats and in apparatus for indicating the water-level in steam boilers and notifying an undue variation in such level." A. A. Dupont. (Communicated by J. Bachrich.) Dated June 17.

2453. "Electric apparatus for working railway brakes." J. C. Mewburn. (Communicated by F. A. Achard.) Dated June 17.

2459. "New applications of electricity for preventing railway accidents and apparatus in connection therewith." A. A. Dupont. (Communicated by J. Bachrich.) Dated June 17.

2460. "Low-water alarms for steam generators." S. and H. N. Bickerton and D. Orme. Dated June 17.

2468. "Apparatus employed in telephonic signalling." E. H. Johnson. Dated June 18.

2526. "Improvements in or relating to signals for use on railways." E. A. Sullivan. Dated June 22.

2539. "Apparatus for operating points and signals on railways." H. Johnson. Dated June 22.

2564. "Galvanic batteries." R. C. Anderson. Dated June 23.

2567. "Automatic railway signals." L. V. Loyd. Dated June 23.

2597. "Electric batteries." A. V. Newton. (Communicated by F. Tommasi.) Dated June 25.

2610. "Telephones or telephonic apparatus." J. H. Johnson. (Communicated by F. A. Gower.) Dated June 26.

2643. "Registering apparatus for use in telephone systems or exchanges." J. H. Johnson. (Communicated by C. J. Bell and S. Taniter.) Dated June 29.

2665. "Improvements in protective and insulating casings or coverings for underground telegraphic, telephonic, or other wires." W. R. Lake. (Communicated by R. B. Lamb.) Dated June 29.

2690. "Method of constructing telegraphic, telephonic, and other wires." C. Mosely, W. F. Bottomley, W. E. Heys. Dated July 1.

2710. "Improvements in and connected with telegraph apparatus." C. Kessler. (Communicated by F. Fuchs.) Dated July 2.

2730. "Automatic electric time signalling apparatus." J. Wetter. (Communicated by W. H. Shuey.) Dated July 3.

2754. "Improvements in signalling upon railways and in apparatus or means for operating signals and other moving points of or connected with railways." S. J. V. Day. (Communicated by J. S. Williams.) Dated July 6.

2761. "Apparatus for operating railway signals, gates, or similar devices." H. J. Hadden. (Communicated by J. A. Emery and J. E. Stuart.) Dated July 6. *(Complete.)*

2764. "Improvements in and connected with electric lamps." G. G. André. Dated July 6.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

4534. "Electric machines." C. W. Siemens. Dated November 6. 6d. Relates to means of regulating the working of dynamo-electric and electro-dynamic machines, by causing those of the one class to produce more or less electricity according as more or less is required to overcome varying electrical resistances in their external circuits, and causing those of the other class to produce more or less motive power according as more or less is required to overcome varying mechanical resistances in the machinery which they are applied to work. The amount of resistance in any branch of an electrical circuit is, other things being equal, dependent on the length of conductor constituting that branch, and therefore when a branch forms the coil of an electro-magnet, its resistance is greater the greater the number of convolutions in the coil. On the other hand, the greater the number of these convolutions the greater is the exciting influence of a given current of the magnet. Instead of making the coils of the stationary electro-magnets of the machines as they are usually made, to present an electrical resistance nearly equal to that of the coils of the rotating armatures, their resistance is largely increased, making it amount to not less than ten times that of the armature coils; and this is done by a great increase of the number of their convolutions, so as to give the circuit of each coil a greatly increased length without reducing the sectional area of the wire of which it consists. Also instead of arranging the connections of the coils of the electro-magnets in the usual way, so as to

bring them into the general circuit of the armature and its external field as part thereof, they are arranged so that the increased coils form portion of a branch circuit connected to the external circuit of the machine beyond the commutator.

4555. "Electro-magnets." JOSEPH BELL and GEORGE SCARLETT. Dated November 8. 2d. Consists in winding two or more coils or helices of wire round the same core, or two or more independent wires insulated from each other in the same coils or compound helices. The first plan the patentees prefer, as they find it much easier to insulate the one from the other than when they are intermingled. Usually the insulating bobbin on which they are wound is formed in as many separate divisions as there are wires, a division for each wire, so as effectually to insulate them the one from the other. Thus presuming there are two bobbins, and each bobbin is divided into two parts, there are four helices or coils with eight ends, four from the bottom or beginning of the coils, and four from the top or finish of the same. Now if they are all right-handed or all left-handed coils, the four bottom coils are united to one terminal of the battery or generator of electricity, and the other four to the other terminal of the said battery or generator. The cores are then placed in the centres of the bobbins. It is claimed that a magnet of far superior power is obtained in this way. (*Provisional only.*)

4572. "Conductors or cables for telephonic purposes." W. R. LAKE. (A communication from E. Holmes and E. T. Greenfield.) Dated November 10. 6d. Intended to prevent or eliminate the effect of induction in electric conductors that are arranged in close proximity to each other. It proposes to braid the wires together into a cable, for which purpose they must be properly insulated to prevent contact of the conducting surfaces. By braiding the wires each one of the system will cross and re-cross each and every one of the others, and the construction being uniform throughout, the nodes occurring at regular intervals, and the curves rising to uniform heights from the axial line of the cable, this regularity of construction producing most advantageous results.

4573. "Electric telegraph apparatus." C. D. ABEL. (A communication from Ernst George.) Dated November 10. 8d. Relates to an improved construction of electric telegraph apparatus, wherein a step by step instrument is combined with a type printing apparatus. A type wheel actuated by a crank-handle is moved in accordance with the index actuated from the distant station and situated on the same letter dial as the said crank-handle, the impression of the corresponding types being effected by the lateral motion or shifting of a ring, or wheel-shaped part, when the crank-handle is made to mark the divisions at which the index stops.

4576. "Electric lamps." T. A. EDISON. Dated November 10. 6d. Consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place. Also in placing such a light-giving body in a nearly perfect vacuum, to prevent oxidation and injury to the conductor by the atmosphere. Likewise refers to the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading wires and the carbon conductor.

4589. "Apparatus for generating electric currents," &c. C. F. HEINRICHS. Dated November 11. 2s. Consists in an improvement on the well known Pacinotti armature; a ring armature in channel form being specially claimed. Also in the general construction of apparatus for generating electric currents continuous; or alternating and multiple circuit currents. Likewise in a brush holder and in various forms of lamps, mostly with circular or curved carbons.

4590. "Electric lighting." G. P. HARDING. Dated November 11. 6d. Relates to the position and feed of the carbons or electrodes, and to the relighting of the electrodes when extinguished. The carbons are placed horizontally, preferably one above the other, with a current having the necessary tension to form the arc at the extremities of the carbons. A shunt is arranged to bring the carbons together gradually or otherwise, and this arrangement can be utilised for several other objects. The expansion by heat of a metal bar is used for feeding the carbons as they consume, and sometimes this expansion is carried so far as to fuse the wire and utilise this fusion of wire as a means of bringing into play the advancing the carbons as they consume; in place of wire sometimes stops of wood or glass are used, the heat of the carbon in the latter case softening the glass so as to allow it to bend, and to pass the stop and put the machinery in motion to bring the carbon forward. This expansion or fusion may be equally employed for liberating a weight, or for acting a ratchet or spring, a lever, or a cam, by the aid of which the carbons are fed the given rate, the feed being thus regular and definite.

4593. "Electrical signal or indicator apparatus." WALKER MOSELEY. Dated November 11. 6d. Relates to electrical signal or indicator apparatus, chiefly designed to be used in connection with an electrical bell, the purpose of the said apparatus being to indicate the room or apartment from which the bell has been rung, or to convey signals of various kinds, as may be desired.

4599. "Insulated electric conductors." J. BELL. Dated November 8. 6d. Asbestos or amianthus paper is wrapped, spirally or otherwise, around the metallic conductor, and secured by any suitable adhesive agent. The same is then plaited or braided with asbestos or amianthus fibres or thread, afterwards being passed through pulped asbestos or amianthus, then surrounded with asbestos or amianthus, wrapped spirally or otherwise, and finally coated with silicate of soda or other agent to bind the whole and withstand moisture.

4613. "Needle sounder for electric telegraph instruments." F. M. ROGERS. Dated November 13. 6d. Intended to enable the ordinary needle telegraph instrument to appeal to the ear as well as to the eye of the operator. (*See* TELEGRAPHIC JOURNAL, Vol. VIII., p. 133.)

City Notes.

Old Broad Street, July 13th, 1880.

THE EASTERN TELEGRAPH COMPANY, LIMITED.—The report of the directors to be presented to the sixteenth ordinary general meeting states that the Company's revenue for the six months ended 31st March, 1880, amounted to £291,194 16s. 2d., from which is deducted £68,637 18s. 8d. for the ordinary expenses of the Company, and £19,896 11s. 9d. special expenditure during the half-year, and £1,990 10s. 2d. for income

tax, leaving £200,660 15s. 7d., which, together with £15,279 8s. 7d. brought forward from the preceding half-year, gives a balance of £215,940 4s. 2d. From this balance, £22,347 12s. 4d. has been paid for interest on debentures, and £20,561 18s. for dividend to 31st March, 1880, on the preference shares. The directors have during the half-year paid an interim quarterly dividend of 1¼ per cent. on the ordinary shares. They now recommend the declaration of a final dividend for the year ended 31st March, 1880, of 2s. 6d. per share, payable on the 16th instant, making, with the three previous payments on account, a total dividend for the year of 5 per cent. on the ordinary shares, and that the balance, £78,205 13s. 10d. be carried to the reserve fund, which will then amount to £262,849 3s. 3d. The steamship *Chiltern* is engaged in restoring communication by the duplicate cable from Vigo to Lisbon. With the exception of this section the Company's cables are all in good working order. The other repairing ships are stationed in the Red Sea and Mediterranean fully equipped in readiness for the Company's requirements. The directors have from time to time received applications for assistance to the relatives of deceased members of the staff, and for the relief of those becoming incapacitated through illness from performing their duties. With the view of meeting such cases for the future, and encouraging the employés of the Company to make provision for the risks to which many of them are especially exposed in the climates where they are necessarily stationed, the board has, subject to the approval of the shareholders, made arrangements by which the Company's officers can secure the payment to themselves of a limited sum at a fixed age, or to their relatives in case of death, the Company paying half the premiums required. It is estimated that if this plan is availed of by the employés generally, the cost to the Company will be about £2,500 per annum. A resolution authorising the directors to carry out this arrangement will be submitted to the meeting. Since the last general meeting the directors have issued 9,600 ordinary shares, and with the proceeds purchased for the Company 9,500 fully paid shares of the Eastern and South African Telegraph Company. They have also provisionally taken, for £95,000 cash, a further 9,500 of those shares, with the dividend accrued thereon since that company's line was opened and established. The returns from the line, during the past six months, have been sufficient to pay a dividend for that period, at the rate of 6 per cent. per annum on the entire share capital, after discharging all working expenses, interest, and amortisation of debentures, and making a substantial reserve for repairs and renewals. The directors are of opinion that the acquisition of the above shares—which, with those already held, will give to this Company £390,000 out of the total share capital of £400,000—is a decided advantage to the shareholders. The meeting will be asked to sanction the payment of the £95,000 for the purpose mentioned. It is proposed for the present to provide the amount required, partly out of the current balances, partly by loans for short periods, and the remainder by the temporary application for that purpose of a portion of the reserve fund; the intention of the Board being to replace all such advances when the renewal or re-arrangement of the debenture debt of the Company is effected. The meeting will take place on the 15th instant at the Terminus Hotel, Cannon Street, at two o'clock.

The Cuba Submarine Telegraph Company, Limited.—The report of the directors for the half-year ending 30th June, 1880, to be presented at the eighteenth ordinary general meeting of shareholders states, that the the gross receipts for the half-year ended 30th June last, including the balance brought from last account, amount to £20,562 4s. 1d., and the gross expenditure to £3,718 3s. 9d., leaving a sum of £16,844 0s. 4d. to the credit of revenue account. Of this, the sum of £4,300 has been placed to the reserve fund, increasing that fund to £32,063 13s. 10d. After providing for the Preference dividend, a balance of £9,544 0s. 4d. remains, out of which the Directors recommend the payment of a dividend on the Ordinary Shares at the rate of 7 per cent. per annum, which will absorb £5,600, and leave £3,944 0s. 4d. to be carried forward to the current half-year's account to meet the cost of the repair of the Cienfuegos-Santiago section of the original cable. The directors regret to report that this section, which the shareholders will recollect was repaired in November last, again gave way in March. Mr. Keith, the Company's engineer, is now engaged in the work of repairing it, intelligence of the completion of which may be received at an early date. It will be satisfactory to the shareholders to learn that the Company's other cables continue in good working order. The director who retires from the Board at this time is Mr. Thomas Hughes, who, being eligible, offers himself for re-election. Mr. James Cowan, the auditor, also retires, and offers himself for re-election. The meeting will be held at the Company's offices, No. 61, Old Broad Street, on the 21st inst., at two o'clock.

At a board meeting of the Direct United States Cable Company (Limited), it was resolved to recommend a final dividend of 5s. per share, such dividend to be payable on and after the 16th August next, making, with the interim dividends already paid, 5 per cent. for the half-year ending 30th June last, carrying forward £21,760, after having carried to the reserve fund £22,847, making it up to £175,000.

The following are the final quotations of telegraphs.—Anglo-American Limited, 62½-63; Ditto, Preferred, 93¾-94¼; Ditto, Deferred, 34⅛-35; Black Sea, Limited, —; Brazilian Submarine, Limited, 8⅝-8⅞; Cuba, Limited, 9⅝-10; Cuba, Limited, 10 per cent. Preference, 15½-16½; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11-11½; Direct United States Cable, Limited, 1877, 11⅛-11⅜; Scrip of Debentures, 102-104; Do., £50 paid, 1-3; Eastern, Limited, 9⅜-9⅝; Eastern 6 per cent. Preference, 12⅝-12⅞; Eastern, 6 per cent. Debentures, repayable October, 1883, 103-106; Eastern 5 per cent. Debentures, repayable August, 1887, 105-108; Eastern, 5 per cent., repayable Aug., 1899, 105-108; Eastern Extension, Australasian and China, Limited, 9⅜-9⅝; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 107-110; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 102-104; Ditto, registered, repayable 1900, 102-105; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 100-102; Ditto, ditto, to bearer, 100-102; German Union Telegraph and Trust, 9-9½; Globe Telegraph and Trust, Limited, 6-6¼; Globe, 6 per cent. Preference, 12-12½; Great Northern, 9⅜-9⅝; Indo-European, Limited, 23-24; London Platino-Brazilian, Limited, 3¾-4¼; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10½-11; Reuter's Limited, 9½-10½; Submarine, 240-250; Submarine Scrip, 2¼-2½; West Coast of America, Limited, 1⅞-2⅛; West India and Panama, Limited, 1¼-1½; Ditto, 6 per cent. First Preference, 7-7½; Ditto, ditto, Second Preference, 6½-7; Western and Brazilian, Limited, 6-6¼; Ditto, 6 per cent. Debentures "A," 100-103; Ditto, ditto, ditto, "B," 97-100; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 34½-35; Ditto, 6 per cent. Bonds, 105-108; Ditto, Second Bonus Trust Certificates, 3½-3¾; India Rubber Company, 15-15½; Ditto 6 per cent. Debenture, 105-107.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 180.

SIXPENNY TELEGRAMS.

THERE can be little doubt now but that the introduction of a sixpenny rate for inland telegrams in the United Kingdom is a matter of certainty, and that the time when the new tariff will come into force will not be long delayed. The Postmaster-General's reply to the deputation on the subject sent by the Society of Arts must, on the whole, be considered as very satisfactory. Mr. Fawcett stated that, so far as the Post Office is concerned, there would be no objection to accept a reduction in the price of telegrams if the reduction could be justified; but he also stated, what must be sufficiently obvious, that if the price charged is not sufficient to make the telegraph service commercially remunerative, the difference would have to be made up out of general taxation; and thus the general taxpayer would be fined in order to enable the senders of telegrams to send them at a lower rate than the market price. In principle, no doubt, this is perfectly correct, and were the use of the telegraph confined to a particular and small class of persons, it would have more weight than would otherwise be the case. The telegraph is, however, for the benefit of every one, and is well recognised as being such, though, of course, from its being inevitably more expensive than the penny post, it cannot be of such universal use as the latter. The general principle of taxing the many for the benefit of the few is so often and inevitably acted upon that it can hardly be considered as being an insurmountable obstacle in the question in point, more especially as the loss which may possibly ensue to the revenue cannot be heavy, and most probably will be no loss at all. It is, of course, necessary to draw the line somewhere. There are a number of undertakings of great public interest which might be undertaken by the Government at a reduced cost, with the probability of an eventual increase rather than decrease in the revenue resulting therefrom. The difficulty is to tell where to stop. It cannot be supposed that the introduction of the sixpenny rate is withheld from other motives than prudence. But even if a slight loss is likely to ensue to the revenue, the extra tax that will be necessary in consequence to make up the deficiency would be so very small, that, considering the advantages gained, it would not be grumbled at, and we feel sure that no one would consider that they are being taxed for the benefit of the few. We are inclined to think that Mr. Fawcett looks upon the telegraph as more of a luxury than circumstances justify, and does not class it, like the penny post, as one of the indispensables of the present century.

That the introduction of the sixpenny rate will cause a great increase in the message work is unquestionable, but to what extent it will go cannot be calculated; estimates on the question must in any case be of a very doubtful character,—there is really no sound basis upon which anything approaching a correct estimate can be made. In our own opinion, however, there can be no fears of the result of the proposed reform.

Although the Postmaster-General naturally hesitates to give a decided answer on the question before him, it is evident that he considers the matter as settled, and the point to be worked out is, how is the reduction in the tariff to be best effected? Mr. Fawcett suggests that a halfpenny word rate be adopted, with a minimum charge of sixpence, the address not being charged for; thus twelve words would be sent for sixpence. The proposal that a commencement should be made by applying the sixpenny rate to messages sent within the London district was, we think, wisely discountenanced by Mr. Fawcett. Want of uniformity is always a mistake, and the fact that a particular company before the transfer undertook the work at the sixpenny rate is really no argument in its favour. Rather than adopt such a change, Mr. Fawcett stated that he would rather wait a year or two and do the matter thoroughly. We quite agree in this; but now that the ball has been set rolling the matter will not stop, and we do not hesitate to say that early next year the desired alteration will be brought about.

CRIGHTON'S PATENT TERMINAL INSULATOR.

THIS invention has for its object the production of a terminal or shackle insulator so constructed as to render the insulation given by it more perfect than is attainable by the existing forms of terminal or shackle insulators used on open wire lines.

The improved terminal insulator is shown in longitudinal section by fig. 1, in plan by fig. 2, and in end view by fig. 3.

To the horizontal arm, A, carried by the telegraph post, B, is attached an insulating hollow conical body, C, by means of a metal encircling strap, D, and bolts, E, around which body is placed another insulating body or shed, F, which partially encloses the former (C) and is attached to it by cement.

Fig. 1.

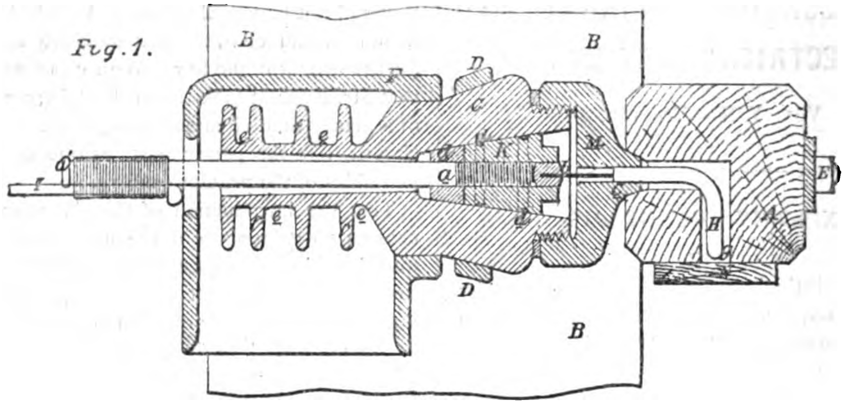


Fig. 2.

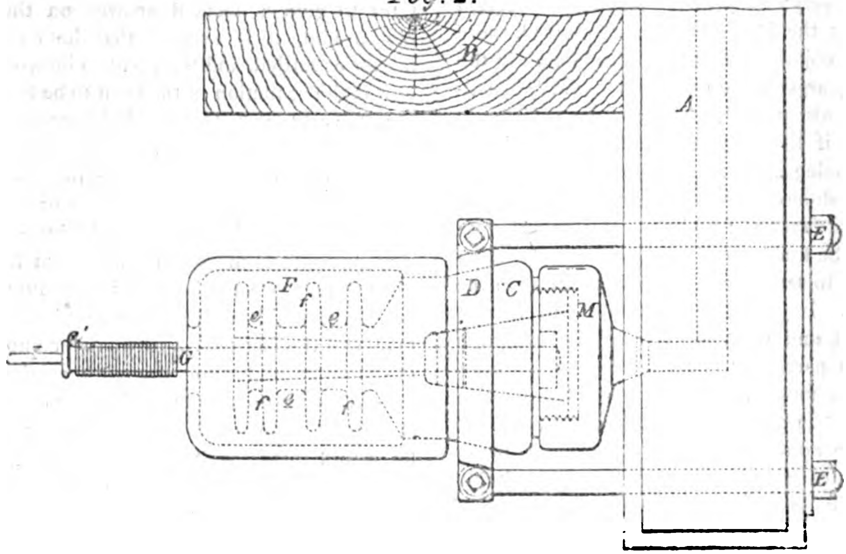
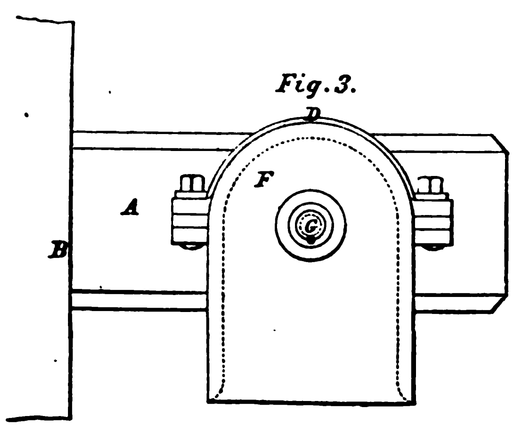


Fig. 3.



Through the centre of these parts so combined passes a conducting rod or bolt, G, for forming the connection between the "leading in" wire, H, and the aerial wire, I, and receiving the strain of the latter. This rod or bolt is screw threaded at its end, *a*, for the reception of a conical protuberence or plug, K, adapted to a similarly shaped aperture in the central body, C, and at this end is the point of junction, *b*, with the wire, H, the extremity of the central body, C, being closed with a screw cap, M, enclosing the end, *a*, of the bolt, G, and the joints at *b*, and leaving an orifice at *c* of a sufficient size only for the passage of the wire, H. The plug, K, which may be composed of any suitable material, is provided with washers or rings, *d*, *d*, of india-rubber or other similar elastic material, so as to form cushions or yielding bodies under the strain exerted by the aerial wire, I. To the end a^1 of the bolt opposite to the end *a* at which the wire, H, is attached, is connected the aerial wire, I, the connection being made in the usual manner. The central body, C, is provided upon a portion of its length with alternate annular or surrounding recesses, *e*, and projections, *f*, the object being to retard the passage of rain or moisture from the conducting rod or bolt, G, to the strap, D, which attaches the insulator proper to the horizontal arm, A. Thus the entry or passage of rain or moisture is first intercepted by the external insulating body or shed, F, but should it gain access to the interior by the rod or bolt, G, the moisture has to traverse the annular undulations, *e*, *f*, of the central insulating body, C, and escape from the other end of the external insulating body or shed, F, before it can arrive at the attaching strap, D, so that the continuity of damp or moisture and liability of the electricity escaping to earth through the rod or bolt, G, and the strap, D, is obviated or greatly diminished.

The horizontal arm, A, is grooved or recessed throughout its length on the underside, as shown at *g*, for the passage of the "leading in" wire, H, and is covered on the underside by a lid, N, so as to completely protect and enclose the wire.

In the case of shackle insulators the apparatus is constructed in substantially a similar manner, with the exception that as no connection with a leading in wire is required, the bolt and its connections are modified, as can easily be understood.

A NEW FORM OF OBACH'S GALVANOMETER.

THE galvanometer of Dr. Obach, which was fully described in the number of the JOURNAL for August 1st, 1879, is similar in form to the ordinary tangent instrument, but the inducing ring, instead of being fixed, is hinged so that it can be turned through an angle, and the effect upon the needle be thereby lessened in a certain definite ratio; by inclining the ring at different angles so as to obtain a similar deflection of the needle with two different currents the relative strengths of the latter can be ascertained, since they will be directly proportional to the *cosines* of the angles through which the ring was turned, from its vertical position, in the two cases. Mr. J. Rapieff has recently devised an important improvement upon this instrument by constructing it with *two* rings, one of which is fixed and the other movable. In measuring the strengths of two currents by this instrument the weaker current is made to traverse the fixed ring and the stronger current the hinged one; the latter is then turned through an angle until the needle of the instrument stands at zero, when the relative strengths of the currents can be determined by noting the angle through which the ring has been rotated. It is obvious that this differential principle is applicable to various kinds of measurements besides those of the strengths of currents.

The general form of the new instrument can be understood from the figure. It consists of two rings, R, R_1, the former of which may be fixed, and the latter movable around horizontal axes.

The left-hand ends of the ring, R, are insulated from each other, and from the axle and frame, and are connected to the terminals, a, a_1; the other ends of the ring, although they are in the sectional figure apparently separated and disconnected, are in reality not so, but are joined together on either side of the axle, so that the ring is practically continuous at this point, though insulated from the axis and the rest of the instrument at that place. Similarly the ring, R_1, is connected to the terminals, b, b_1, and is continuous but insulated from the axis, &c., at the left-hand side of the instrument.

The rings and axes are mounted on a stand with levelling screws, and to this stand is also fixed the dial and pivot of the magnetic needle, *n s*.

A graduated circle (not shown in the fig.) is attached to the stand, by means of which the angle through which the movable ring may be turned can be observed.

Two kinds of needles can be used with the instrument, viz., a short one with a long pointer fixed to it; this would be used when the instrument is worked as an ordinary Obach galvanometer. The other may be made of any reasonable length, and may be employed with advantage when the instrument is used differentially.

Comparative measurement of two current strengths.

Supposing the instrument to be set so that when no current is passing through either ring, the needle stands at zero. In fig. 2 let a and β represent the angles of inclination made with the horizontal plane by the fixed and movable rings, R, R_1, respectively, and let C and C_1 be the currents traversing the two rings in opposite directions; then when the needle is at zero

$$C : C_1 :: \sin. \beta : \sin. a,$$

or

$$C \sin. a = C_1 \sin. \beta;$$

that is

$$C_1 = C \frac{\sin. a}{\sin. \beta}.$$

But since in the actual instrument the distance between the needle and the two rings is not the same, constants representing these distances must be introduced into the foregoing formulæ in order that they may be true.

Let the constant for the ring R be p.
 „ „ „ R_1 „ q.

And also, if the rings be made of a number of turns of wire instead of a single band, then

Let the number of turns on R be n.
 „ „ „ R_1 „ m.

And therefore the preceding formula becomes

$$C_1 = C \frac{np \text{ sin. } a}{mq \text{ sin. } \beta}.$$

If the inclination of the ring R be 90°, *i. e.*, if it be perpendicular to the horizontal plane in which the magnetic needle lies, then

$$a = 90 \text{ or sin. } a = 1\,;$$

therefore we get

$$C_1 = C \frac{np}{mq \text{ sin. } \beta}.$$

The values of n, m, p, and q are easily determined in the first instance experimentally, in which case the formula may be written

$$C_1 = C \frac{K}{\text{sin. } \beta}$$

where $$K = \frac{np}{mq}$$

resistances would have their other ends connected respectively to terminals, a_1 and b_1, of the galvanometer.

The current being thus made to pass through the two rings in opposite directions, the movable ring must be turned until the needle is brought back to zero.

Let X be the unknown resistance in the circuit of the ring, R, whose resistance we will call R.

Let Y be the resistance in the current of the ring, R_1, whose resistance we will call R_1.

Taking the angles and constants the same as before, then we have

$$C : C_1 :: mq \text{ sin. } \beta : np \text{ sin. } a,$$

but also $$C : C_1 :: Y + R_1 : X + R,$$

therefore

$$Y + R_1 : X + R :: mq \text{ sin. } \beta : np \text{ sin. } a,$$

therefore

$$(X + R)\, mq \text{ sin. } \beta = (Y + R_1)\, np \text{ sin. } a,$$

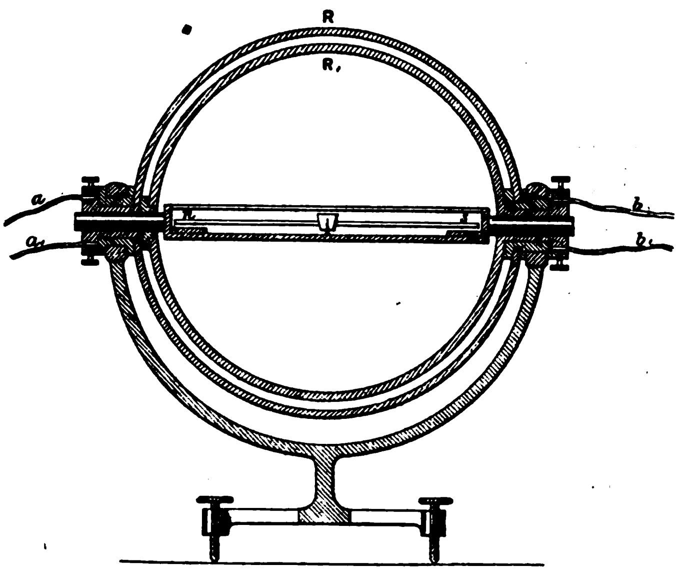


FIG. 1.

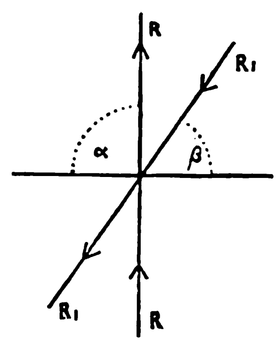


FIG. 2.

Determination of the value of unknown resistances.

The instrument being set so that the needle normally stands at zero, then in order to determine the values of resistances by the new galvanometer the latter would be used in the following manner:—

One pole of the battery would be connected to terminals, a and b, the other pole would be connected to one end of a known resistance and also to one end of the unknown resistance, and these two

that is

$$X = (Y + R_1) \frac{np \text{ sin. } a}{mq \text{ sin. } \beta} - R$$

if $a = 90°$, or sin. $a = 1$, and we put $\frac{np}{mq} = K$,

then $$X = \frac{(Y + R_1)\, K}{\text{sin. } \beta.} - R$$

MR. FAWCETT ON POSTAL TELEGRAMS.

A DEPUTATION from the Council of the Society of Arts waited upon Mr. Fawcett, the Postmaster-General, on July 17th, at the General Post Office, for the purpose of bringing before him the subject of the cost of inland telegrams, with a view to its reduction by the substitution of a minimum charge of 6d. for inland messages in place of the present charge of 1s. Amongst the gentlemen forming the deputation were Lord A. Churchill, Mr. Andrew Cassell, Mr. E. Chadwick, Mr. G. C. Barclay, Admiral Sir F. Nicholson Banks, and Rear-Admiral Mayne, C.B.

Lord R. CHURCHILL and Mr. CHADWICK having urged that the hour had arrived when it was thought that a great advantage might be conferred upon the country by a reduction being made in the cost of inland telegrams,

Mr. FAWCETT, in reply, said: No member of this deputation can recognise more fully or strongly than I do the great advantage which would be conferred upon the entire community by a reduction in the price of telegrams, or by the adoption of any other means which would facilitate internal communication. Probably no service which can be rendered by a Government to a country is so great as that of facilitating the means of communication. In order that there may be no misunderstanding, I wish to state at the outset of my remarks, with as much distinctness as possible, that so far as this department is concerned, there would be no objection to accept a reduction in the price of telegrams if the reduction could be justified. In saying this, I think I am expressing the views of my colleagues and other officials of the department. In estimating what ought to be the price to be charged, I think we ought to keep steadily in view these two principles. If the price charged is not sufficient to make the telegraph service commercially remunerative, the difference would have to be made up out of general taxation, and thus the general taxpayer would be fined in order to enable the senders of telegrams to send them at a lower rate than the market price. It seems to me that this would be just as indefensible as to impose a tax upon the community in order that a grant in aid of a certain class of wages might be given, or to give a bounty to some particular trade in order that the commodities of that trade might be sold below cost price. On the other hand, I wish with equal distinctness to state that if a price is charged for a telegram more than sufficient to make the service remunerative, then the difference between the price which would make it remunerative and the price charged is really so much taxation imposed upon telegrams just in the same way as if the tax-gatherer stood over the sender of the telegram and levied a tax at the moment the telegram was sent. If it could be proved that 8d. would be a remunerative price, then if 1s. is charged, 8d. is paid for the service rendered and the other 4d. may be regarded as a tax imposed upon telegrams. It is obvious that it is not for this department, nor for me holding the office I hold, to express an opinion as to the way in which the taxation of the country should be raised, or whether it is advisable or not that the taxation of the country should be raised upon the means of internal communication. That is a question not for this department, but for the Chancellor of the Exchequer and the Government generally. The principles I have laid down at starting, I think it important to keep steadily in view, because it seems to me that upon them must chiefly be determined the price that ought to be charged for telegrams. Of course, every one would like to have the price of telegrams reduced, but the question must be determined by financial considerations, and those considerations I will endeavour to lay before you as distinctly as I can and with as much brevity as possible. The telegraph revenues show an improvement in the best sense of the word, because I find not only the gross receipts increasing, but the net receipts increasing in a more rapid ratio. I will give you the gross and net figures for the year 1876 and for the last financial year, which closed on the 31st March last, and you will see that they abundantly prove the satisfactory result I have mentioned. The gross receipts from the telegraphs in 1876 were £1,287,000, while the outlay for working expenses, renewals, &c., were £1,090,000, which shows a profit realised of £197,000. I refer to the year 1876, because it was the year in which a very important Select Committee of the House of Commons, presided over by Dr. Lyon Playfair, inquired into the telegraph system of the country. Passing on to the year which closed on the 31st March last, we find that the gross receipts have increased to no less a sum than £1,471,000, but that the working and other expenses have not increased in anything like the same ratio, owing to great economy being introduced into the service and in consequence of improvements in the means of telegraphing. This largely increased revenue was obtained at a comparatively slight addition of cost. I find that the working expenses only increased from £1,090,000 in 1876 to £1,117,000 last year, so that the profit for the last financial year was £354,000. The profit during the past four years has increased from £197,000 to £354,000. The result becomes the more satisfactory when we turn to the capital account. I find that this increase in profits of nearly £160,000 was obtained with a comparatively small addition to the capital account of about a million. During the present year the progress seems to be going on in an increasing ratio, for comparing the receipts from telegrams for the first three months of the present year with the corresponding three months of the previous year, I find an increase in receipts amounting to £80,000, and my friend Mr. Patey, the superintendent at the head of the department, considers, after making careful estimates, that the profit on telegraphs during the present year will amount to £450,000. Of course, a considerable portion of this increase is due to the extended work of the telegraphs and to the general advancement of the system throughout the country. But I am bound in candour to admit that no small part of this satisfactory result is due to the admirable manner in which the telegraph service has been managed by the permanent officials, and their readiness to adopt suggested economies and take advantage of scientific improvements. Having laid these financial results before you, I will proceed to consider what would be the best method of reducing the price of telegrams, and then I will lay before you what would be the probable result of the suggested reduction. Now of all the many suggestions made for reducing the price there seems to be a particular one which has so many advantages over the others that I shall almost entirely confine my attention to it. As you are probably aware, all foreign telegrams are sent at what is known as the word rate. If, for instance, you send a telegram to France or Belgium the charge is at per word, and the result is that short telegrams can be sent to the Continent at less cost than those sent from one part of England to another. It seems to me that if any change be made in the present rate it should be in the direction which this country has so persistently pressed upon other countries. The plan suggested and which I would recommend is a modification of the word rate. I would propose, for instance, a halfpenny word rate, and that the minimum charge should be sixpence. Consequently a telegram of twelve words, including the address, could be sent for sixpence, and a halfpenny a

word would be charged for every additional word. Now it seems that there are several advantages to be derived from the adoption of this particular method of charge. In the first place it would prevent the waste which prevails under the present system. It is notorious that in the great majority of telegrams sent a great many unnecessary words are used, and if the word rate were adopted this would not continue. Then another advantage would be that a person would be charged according to the amount of work which the State did for him. At present there is this anomaly—that a person may send a single word and a short address, and be charged as much as the person who sent twenty words and a long address. It has been suggested that there should be two rates charged—sixpence and a shilling—and that the shilling messages should always take precedence. I would never sanction such a scheme as that, as I regard it of the greatest importance to make no distinction in messages, and that the first in the office should be first sent out. I have now to direct your attention to the important question as to what would be the financial effect of adopting the sixpenny rate. Soon after I was appointed to the office I now hold, my attention was directed to the subject, and I asked Mr. Patey to prepare a careful estimate of what would be the probable effect of reducing the price of telegrams to sixpence for twelve words, with a charge of a halfpenny a word for every word beyond that. Without troubling you with details, I will give you briefly the result of Mr. Patey's estimates. He estimates that if the sixpenny rate had been adopted this year there would have been a falling off in the income, and that the working expenses would have been augmented by some £50,000. The diminution in the receipts would amount on the year to £112,000, and he also estimates that during the present year the additional capital expenditure necessary for new wires and office accommodation would be £100,000. Treating this as capital to be paid off in a certain period by a sinking fund, I will set down for it an annual charge of £5,000. Therefore you have £50,000 increased working expenses, £112,000 for loss of revenue, and £5,000 for interest on extra capital. This gives a total of £167,000 as representing the estimated cost of the reduction in the price for one year. I think it quite possible that, although the reduction would lead to an immediate loss of revenue, like other improvements, it would ultimately prove remunerative. It may be asked, "Why do you not introduce the 6d. tariff on a limited scale, say for London and some other large towns?" As a metropolitan member, you may suppose that I would not like unnecessarily to oppose any proposal to give special benefits to the metropolis. It is said that London has a special claim because 6d. telegrams existed before, but I do not think that the public derived much advantage from that, as the cost for porterage was very heavy. Moreover, the facilities which the Government have offered to London since it took over the telegraphs are remarkable. At the time the telegraph purchase was made there were only 60 offices in London, whereas at the present time there were 400, and the number was steadily increasing. So great in fact has been the increase in the amount of business done that the number of messages sent from one part of London to another had risen from 250,000 when the telegraphs were taken over to a million and a half at the present time. I will now consider what would be the financial result of the reduction in price for London and some other large towns only. I find that it would only diminish the loss by about £50,000 or £60,000, and still leaving by the reduction a loss in revenue on the year of £120,000. I think it would be extremely unfortunate, for the sake of £50,000 a year to deprive the entire country of the benefits of an uniform rate. As at present advised, I would rather wait for a year or two, and have the thing done completely. I think I have said enough to show you that the question of the reduction of the price of telegrams is a financial one which cannot be determined by myself or this department, but must be considered by the Chancellor of the Exchequer and the Government generally. In conclusion, allow me to make this remark, which it seems important you should bear in mind, that I cannot help thinking that the true position of the Post Office in this country is this: It has two distinct duties to discharge—the first being to supply revenue, and the second to supply certain services for the country. The amount of the revenue the Chancellor of the Exchequer has to determine, whilst we have to provide the maximum advantage for the community. If it should be decided that the country is in a position to sacrifice £167,000 of revenue, I certainly would offer no objection to the reduction.

The Deputation then thanked the right hon. gentleman, and withdrew.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XIV.

BATTERIES—(*continued*).

THE "Chamber" battery, which was described in the last article, although very convenient, is not all that can be desired. From the fact of its being made in so many parts it is liable to sustain damage, especially during transit, and, moreover, it cannot be packed for the latter purpose except in considerable bulk, from the necessity of packing material being placed between each porcelain chamber. Now, except as regards the porous partition, the "Ordinary" sulphate battery is very substantial in make, and is not liable to damage from rough usage; a form of battery, therefore, which would combine the strength of the "Ordinary" and the conveniences of the "Chamber," would obviously be a good pattern. These facts have been thoroughly appreciated, and at the present time a battery constructed on these lines has commenced to be employed in the Postal Service, and will form the standard sulphate battery in all cases where the Daniell description is necessary.

The new battery will be called the "Daniell" simply; its cells are of rather greater dimensions than those which have been hitherto in use, and from the consequent large size of the zinc and copper plates, their internal resistance is small.

Like the "Ordinary," the new pattern battery consists of a teak trough divided into cells by slate partitions, the whole of the inside being coated with marine glue, so as to render the cells perfectly water-tight; a small partition about half an inch high is set at the bottom of each cell so as to keep the porous pots in their place. The shape of these pots is similar to those shown by fig. 61 in the last article, and the zinc and copper plates are like those indicated by fig. 60 in the same article. The general arrangement of the cells will be understood from fig. 62.

The trough of the battery is 18 inches long, 9 inches wide, and 9 inches deep, including the lid; it is divided into five cells. The porous pots are

$4\frac{1}{4}$ inches high, $5\frac{1}{8}$ inches broad, and $1\frac{3}{4}$ inches from back to front. The zinc plates are $4\frac{3}{8}$ inches wide and $2\frac{1}{2}$ inches deep without the lug, which latter is 1 inch long and $1\frac{1}{4}$ inches wide, the latter dimension corresponding to the width of the copper strap connecting the plates. The copper plate is 4 inches wide and $4\frac{1}{2}$ inches deep.

The action, charging, maintenance, &c., of the new pattern battery are precisely similar to those described for the other forms.

The U. K. Battery.

This battery, which is still extensively used in the Postal Service, is so called from its having been the form employed almost universally by the "United Kingdom" Telegraph Company previous to the transfer of the latter into the hands of the State.

Fig. 63 represents this form of battery. Each cell consists of a round glazed brown earthenware jar, 5 in. high and $4\frac{1}{2}$ in. wide, holding one quart. A zinc cylinder, slightly smaller in diameter than the inside measurement of the cell, is contained in the latter. This cylinder is of cast-zinc, and weighs about $2\frac{1}{4}$ lbs.; it is not continuous all round, but is cast with a gap; if this were not the case it would be impossible to remove any particular cell without dismantling a large number, perhaps all, the cells in a set. A porous pot of white unglazed porcelain is placed concentrically within the zinc cylinder, and contains a copper plate bent into a cylindrical form; the top and bottom of the porous pot are saturated to a distance of half an inch from their ends with paraffin wax or ozokerit. Crystals of sulphate of copper are placed inside the porous pot, and the cell is charged and cleaned in the same way as the cells of other forms of Daniell's battery.

From fig. 63 it will be seen that the porous pot is set upon a little tripod; this is formed of gutta-percha, and having a recess in it in which the porous pot fits, it serves to keep the latter concentric with the zinc cylinder.

From the large size of the electrodes, the U. K. battery has a very low resistance, which is a great advantage for certain purposes.

Although a very large number of U. K.'s are at present in use, it is intended that they shall be superseded by the new "Daniell" battery.

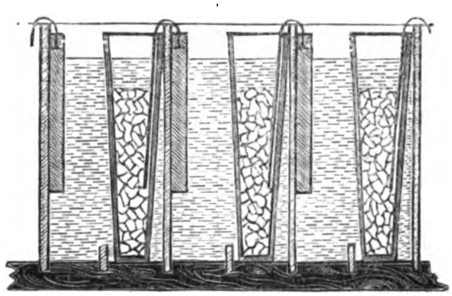


Fig. 62.

Fig. 63.

Faults prevalent in Daniell Batteries.

The marine glue coating the joints in the slate partitions sometimes chips off; this causes the zinc and copper pair hanging over the division to be on short circuit and to exhaust the sulphate crystals and solution in which the copper plate is immersed. The fact of this exhaustion will at once enable the faulty partition to be detected. A fault of this kind practically throws two cells out of use, and can be remedied temporarily by connecting the copper straps of the next and the preceding cell together

by a piece of wire; the chambers on either side of the faulty partition should also be emptied, as, although not absolutely necessary, it stops the waste going on in those cells. In the "Ordinary" battery the porous partition sometimes becomes cracked, allowing the sulphate of copper solution to enter the zinc chamber; in this case the copper straps of the plates on either side of the faulty porous partition should be bridged across with a piece of wire, so as to cut the cell out. The porous partition also sometimes becomes so hard as to offer a very high resistance; the temporary remedy is the same as in the last case. Where the fault is caused by a faulty porous *pot*, of course the remedy is obvious.

It occasionally happens that one cell will have all its sulphate crystals exhausted before those in its neighbours'; this may be due to a deficiency of the salt in the first instance, but is more likely to be owing to a faulty partition.

THE LECLANCHÉ BATTERY.

This battery consists of a glass jar, containing a solution of the ordinary commercial sal ammoniac (which is a combination of hydrochloric acid and ammonia). A zinc rod, into which a connecting tinned iron wire has been cast, is placed in the solution and forms the positive element, whilst a plate of carbon, surrounded by a mixture of broken gas-carbon (or coke) and peroxide of manganese, and contained in a porous pot, forms the negative element. To make an attachment for the terminal, the top of the carbon plate is capped with lead, which makes good metallic contact with the carbon, and is not liable to be attacked by ammonia, as brass would be. The upper part of the carbon plate is dipped in melted paraffin wax to fill up its pores; if this were not done, the liquid would ascend by capillary action and attack the lead cap, forming a layer of white lead, which would cause a disconnection; this was a common fault in the earlier batteries.

Lastly, the wire, the top of the zinc rod, and the lead cap of the carbon plate are covered with pitch, ozokerit, marine glue, or some other compound, to protect them from local action.

The action of the Leclanché battery is to dissolve the zinc and form zinc chloride, and some other salts of zinc which are not soluble in water, but are soluble in a solution of sal ammoniac and water; to reduce the peroxide of manganese to a lower oxide; and to form ammonia, which is given off as a gas. Thus, after a time, new zinc will be required, the sal ammoniac must be replaced, and the porous cell which contains the peroxide of manganese must be renewed. When the solution of sal ammoniac becomes too weak to dissolve the zinc salts, they form themselves in crystals on the zinc rod and porous pot, and if the solution becomes too highly charged with these salts (super-saturated), the crystals form in the substance of the porous pot and crack it. This is prevented by a periodical renewal of the sal ammoniac solution.

As was first pointed out, there is no local action or waste of material when the battery is not in action, so that, if the evaporation of the liquid is prevented, it may be allowed to remain untouched for months or even years without losing power. The time the battery will last is entirely dependent on the amount of work it has to do.

It polarises so quickly that it should not be employed for local battery purposes or for double current circuits, or circuits where permanent currents are used.

To charge the Battery.

The glass jar must be filled about half an inch high with crushed sal ammoniac, about 2 oz. in weight, and the porous pot and zinc rod set in their places. The glass jar must next be *half filled* with water. A little water must also be poured into the porous cell through the holes in the top, to moisten the manganese mixture and to establish a conducting medium between the different sections of the battery.

Care must be taken that neither water nor sal ammoniac remains on the terminals, otherwise local action and corrosion will set in.

No portion of the protecting compound about the top of the battery should be knocked off; if it is, the exposed portion must be varnished or covered afresh with the compound. A cement composed of three parts by weight of ozokerit and one part of Chatterton's compound is that which is generally used, and which is found to be very tough and not liable to chip off.

The battery must be kept dry and clean. It should not be fixed in a warm place, otherwise evaporation takes place too rapidly and crystals form on the surface of the glass, which, by capillary action, will often drain off nearly the whole of the liquid. It should be examined periodically, according to the amount of work it has to do. The solution should be bright and clear. If it has become cloudy, it is an indication that sufficient sal ammoniac is not present to dissolve the zinc salts. *All* the solution should then be drawn off and the cell again charged, as at first, with a fresh supply of sal ammoniac and water. The porous pot and zinc rod should then be thoroughly scraped and cleaned. The crystals which have formed on the porous pot are best removed with a damp cloth. If the pot shows signs of cracking, it must be replaced by a sound one. The zinc rod, when reduced to half its original size, should be replaced.

The connecting wire should be carefully examined, and any portion of the metal which may have become bare should, after being thoroughly cleaned, be well covered with the cement above described. If this is not done, the ammonia fumes will speedily eat through the wire and cause a disconnection. If there be none of the cement at hand, a piece of tallow well laid on will prevent corrosion for some time, but no time should be lost in procuring a supply of the cement.

Faults prevalent in the Leclanché Battery.

The cracking of the porous pot, due to the formation of crystals in its pores. The corrosion of the connecting iron wires, due to the action of ammonia. The disconnection of the connecting wire of the carbon plate, due either to the lead cap making imperfect contact with the carbon or to the formation of salts of lead between the lead and the carbon. The cracking of the glass jar, due to imperfect annealing, also takes place sometimes, but this fault

is much less frequent than it used to be, as more care is taken in the manufacture.

THE BICHROMATE BATTERY.

This battery is made in two sizes; the smaller size consists of a glass or stoneware jar of the same size and pattern as that employed for the "U. K." battery. Inside this jar is placed a porous pot containing a short stout zinc rod with a broad base; a little mercury is also placed in the bottom of the pot, which keeps the zinc well amalgamated. In the outside jar is placed a carbon plate about two inches wide and a ¼-inch thick. A small lead cap is fixed to the top of the carbon, a piece of platinum foil being placed between the two; the upper part of the carbon has its pores filled with paraffin wax. The connections made in this way are very satisfactory and are never known to fail.

To charge the Battery.

In the outer jar (small size) are placed 4 oz. of a prepared bichromate salt, which consists of bichromate of potash in combination with sulphuric acid, also 4 oz. of sulphuric acid are added; the jar is then filled up with water. In the porous pot 2 oz. of mercury are placed, and it is then filled up with water. If the battery is required for immediate use about half a teaspoonful of sulphuric acid is added in the porous pot, but this is not necessary if the current is not required for a day or two after the charging.

When the battery is charged a portion of the sulphuric acid passes into the zinc cell, and, when the battery works, this acid attacks the zinc and forms sulphate of zinc, while the hydrogen generated at the carbon plate reduces the bichromate of potash to a lower form. The mercury keeps the zinc perfectly amalgamated, so that but little local action takes place; there is secondary action in the battery when the solutions become saturated, which results in the formation of beautiful dark violet crystals of "chrome-alum" on the carbon plate. This is a double salt, a sulphate of chromium and potassium.

The secondary action just referred to is only to be prevented by the occasional withdrawal of some of the liquid and its replacement by fresh sulphuric acid and water, an operation which should be performed immediately the deposition of crystals is detected. The crystals themselves should of course be removed.

As long as the colour of the bichromate solution remains *orange* little need be done, but if it turns *blue* fresh bichromate salt should be added; if the colour remains orange, and yet the battery fails, some fresh sulphuric acid must be added. At the same time half of the solution in the porous pot should be replaced with water.

If the battery does little work it will last three or four months without being touched, but if it be worked hard it must be examined about once a month.

If the solution becomes blue, notwithstanding the presence of a sufficiency of bichromate salt, and the zinc becomes dirty and coated with deposit, the battery must be entirely cleaned. In doing this great care should be taken not to waste the mercury either in the pot or on the zinc. The best plan is to insert the pot and its zinc undisturbed in an open jar, and place them under a water tap. The whole of the solution in the pot, together with the deposit, will then be washed away, but the mercury will remain behind. The carbon and the outer jar simply need washing in water; the battery can then be charged as before. Crystals that remain in the cells unchanged in colour can be used again, but all others must be rejected. The zinc can be used as long as any portion remains.

SECONDARY BATTERIES WITH CARBON ELECTRODES.

By SAUVAGE HENRI, Commis Principal des Télégraphes at Evreux.

IN his researches on electricity, M. Planté has studied the secondary currents produced by voltameters with plates of copper, silver, tin, aluminium, iron, zinc, gold, platinum, and lead, these last two metals giving the most intense secondary currents, and the most utilisable in consequence of the long duration of the latter and the conservation of the charge on the plates when the circuit is open.

The study of a voltameter with carbon electrodes deserves to be made also.* To commence with, in this voltameter, if the gas obtained by electrolysis of the water is collected, it will be found that the gas from the positive pole only measures about ⅛th of that disengaged from the negative pole; there has, therefore, been an absorption of carbonic acid, the formation of which, under these circumstances, has been proved amongst others by M. Becquerel in his *Traité Experimental de l'Eléctricité*, page 243, Vol. III., published in 1835. At the negative pole there is undoubtedly a production of hydrogen and carbureted hydrogen, as in the elements with carbon and zinc electrodes which I experimented upon and published a description of in *Annales Télégraphiques* for July, 1875.

By prolonging the action of a battery composed of seven small sized Callaud cells, and a voltameter formed by two rectangular carbon pencils immersed in distilled water, acidulated by a small drop of sulphuric acid, I obtained a result which appears never to have been noticed before. At the end of seven or eight hours, the carbon which received the oxygen in a continuous manner commenced to disengage it, and the water assumed a black tint, which continued to become darker, until the complete disintegration of the portion of the positive carbon immersed in the liquid took place; the other carbon remained intact.

This water, when passed through a Berzéhein filter, remained black after having left on the paper finely divided carbon; treated with acetate of lead it lost its colour. It appears amongst other things that this colour is not due to finely divided carbon held in a state of suspension. A leaf of paper with which the voltameter was left covered showed, after the experiment, black, smoky deposits; on the other hand, if the voltameter was carefully examined by a strong light, bubbles of gas could be

* A voltameter with carbon electrodes was employed some time ago by Mr. Varley to give time signal currents.

seen detaching themselves from the carbon, and carrying with them particles which fell gently back when the bubbles cleared, rising and falling again according to the jerks and alterations of the bubbles as they moved about, finally deposit themselves at the bottom of the glass vessel, to remain in suspension, or to burst out unmistakably with the gas outside the water, according to their degree of tenuity.

This state of extreme division has been observed before with gold under the effect of electric discharges, a red powder being deposited. "It appears," says M. Becquerel, page 305, Vol. III., of his treatise, "that this state is due to the extreme fineness of the division of the particles, since it cannot be admitted that gold oxidises at the temperature at which its oxide ordinarily reduces itself.

Two Callaud elements do not produce this disintegration; they fall to zero, and all disengagement ceases. Three elements produce it feebly and gently after 20 hours' action on closed circuit. With four elements the disintegration is more lively. And finally, with seven elements, the action takes place after seven or eight hours with the circuit closed.

It appears that this disintegration of the carbon at the positive pole is an action analogous to that which M. Planté noticed in his lead plates; after a long "formation" the plate acquired "a peculiar crystalline aspect, and the molecular construction of the metal became altered to a certain depth, the peroxidised plate becoming even rather brittle."

The voltameter with simple electric light carbons gave a secondary current, which produced full deflection on the needle of a zinc galvanometer, and then allowed it to fall back to 7° after being on closed circuit through no other resistance for two minutes; after rest it again produced the full deflection, which latter fell back quickly to 7°, and then slowly to zero.

The study of the secondary current given by large surfaces is interesting. An element formed by means of grains of gas carbon placed in a porous pot of a capacity of about 200 cubic centimetres, and placed in the midst of an equal volume of grains of carbon in a Callaud jar, was charged by a battery of seven Callaud elements; the secondary current observed on the zinc galvanometer, without any other resistance, fell from full deflection to 7° after three minutes of closed circuit; it remained still at 135°* five days after the charging, and after six other observations, or after five days of repose and eight minutes of discharge taken seven times.

The couple was compared during this time with an element with lead plates, exposing three square decimetres of surface, "formed" as near as possible on the method of M. Planté. After having been charged by the same battery and during the same time, the Planté element fell 25° in three minutes; it did not give more on the fifth day, after five discharges of a total duration of five minutes, than a jump of 70°, falling back immediately to 5°.

The element with carbon electrodes remained still at 90° on the 20th day, and at 80° on the 25th day after 26 observations.

* In default of another means, all the deflections higher than 90° have been taken by leaving the dial of the sine galvanometer fixed at that point.

This experiment, confirmed by others numerous and repeated, establishes the fact that the element with carbon electrodes gives a secondary current of an intensity equal to, and of a duration superior to, those which are obtained from lead electrodes.

Nevertheless, the advantage is to the latter as regards quantity, at least, with the elements tried; the elements with lead plates would raise to a state of redness for 10 seconds a thin platinum wire, when the elements with carbon electrodes would scarcely warm it; the two joined up for quantity would keep it red for 45 seconds.

This should be the case: from the surfaces of the lead plates being very close together, from the great affinity of peroxide of lead for the hydrogen, and from the absence of any solid diaphragm, the reaction should be more sudden and prolonged between the two plates of lead of the Planté system than between the masses of carbon in which the gas is occluded.

If an element is constructed with an electrode of carbon exposing a divided mass, and an electrode of lead exposing a surface, one obtains, by having hydrogen on the carbon and oxygen on the lead, a secondary current of less quantity than that obtained from the Planté system, and of less duration than that of the system with two carbon electrodes. In three minutes the current falls from full deflection to 105°, but it gave 90° still at the end of 12 days after charge and after 11 observations; it gave 80° on the 17th day, and at the end of 24 days and 23 observations the deflection was still 58°.

A similar element charged in the reverse way fell to 15° on the fourth day after four observations of a total duration of four minutes.

(*To be continued.*)

Notes.

THE BRITISH ASSOCIATION.—The fiftieth meeting of this Association will be held at Swansea this month. The President Elect is Professor A. L. Ramsey, LL.D., F.R.S., Director-General of the Geological Survey of the United Kingdom. The inaugural address will be delivered on the evening of the 25th August, when the existing President, Professor J. Allman, will resign. The first *soirée* will be held on Thursday, August 26th, and there will be a second on Tuesday, August 31st. The session will be closed on September 1st by a general meeting at 2·30 p.m. The Swansea reception rooms will be opened for the convenience of members and visitors on Monday, August 23rd, at 1 p.m. On the following days they will be opened at 8 a.m. The following is a list of the officers for the various sections, subject, of course, to any possible modifications:—Section A. Mathematical and Physical Science. Professor W. G. Grylls Adams, President; Messrs. J. A. L. Glaisher, Oliver J. Lodge, D. MacAlister, and W. E. Ayrton, Secretaries. Section B. Chemical Science. Mr. J. H. Gilbert, President; Messrs. H. B. Dixon, Eaton Hodgkinson, Phillips Bedson, and J. M. Thomson, Secretaries. Section C. Geology. Mr. H. C. Sorby, President; Messrs. W. Topley and W. Whitaker, Secretaries. Section D. Biology. Mr. A. C. Gunther, President; Messrs. Bloxam M'Nab, Priestly, and Howard Saunders, Secretaries. Section E. Geography.

Lieut.-General Sir John H. Lefroy, President; Messrs. H. W. Bates, C.G.D., Black, and E. C. Rye, Secretaries. Section F. Economic Science and Statistics. Mr. G. W. Hastings, President; Messrs. N. A. Humphrey and C. Molloy, Secretaries. Section G. Mechanical Science. Mr. James Abernethy, President; Messrs. A. T. Atchison and H. Trueman Wood, Secretaries.

Arrangements have been made for visiting several important metallurgical works in the vicinity of Swansea, which will impart a special interest to the excursions that form so attractive a feature to the annual meetings of this Association.

THE *Gazette of India* announces the appointment of Mr. Mance as engineer and electrician to the Persian Gulf Telegraph. Mr. G. Sealy, late assistant superintendent Persian Gulf Telegraph, is promoted to superintendent; Mr. R. C. Laughlin, assistant superintendent 1st grade Indian Telegraph Department, is appointed to officiate as superintendent 3rd grade from May 18.

AUSTRALIAN TELEGRAPHY.—The Postmaster-General of South Australia has received a letter from the Deputy Postmaster-General of Victoria, acknowledging the receipt of a letter, notifying the approaching completion of the proposed new telegraph line between Adelaide and Melbourne, and stating in reply to Mr. Todd's inquiry respecting the progress made in Victoria with the line to connect therewith, that directions have been given for a survey of a line from Dimboola to be proceeded with immediately, with a view to establish the necessary connection at as early a date as practicable.—*Engineering.*

AN article from the pen of Mr. J. Laister, of the Telegraph Department, General Post Office, entitled "The Whitewashing of Shylock," appears in the July number of *Modern Thought.*—*The Civilian.*

POSTAL TELEGRAMS.—The petition transmitted by the Council of the Society of Arts to the Postmaster-General, asking him to reduce the tariff of inland telegrams, runs as follows:—

To the Right Honourable Henry Fawcett, M.P., Her Majesty's Postmaster-General.

The Memorial of the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce

Respectfully sheweth,—

That the Council are strongly of opinion that the time has now arrived when the charge on inland telegrams might be reduced, and a minimum charge of sixpence substituted for the present one of a shilling.

They submit that the charges on inland telegrams in this country are higher than in other European countries, the rates in France, Germany, Belgium, and Switzerland all being lower than in England. It is even a curious anomaly that a telegram can be sent from any part of the United Kingdom to Belgium or to France for less than the smallest sum for which a telegram may be sent from one part of London to another.

The Council do not propose to make any suggestions as to the details of the method by which the reduction of charge should be effected; whether by employing a lower tariff within certain limited districts, such as the metropolis and its suburbs, or the country within a certain radius of a provincial town; or, secondly, by adopting a word-tariff, with a minimum charge of 6d. The precise details are, the Council feel, safely to be left to the department itself.

They feel sure, however, that a reduction in the tariff would be accepted as a boon by a large number of those who are prevented by the present rates from using the telegraph as largely as they would wish, and that the business of the department would soon be so increased as to fully compensate for the lessened revenue which might be the first consequence of the proposed change.

(Signed)

ALFRED S. CHURCHILL, Chairman of the Council.
H. T. WOOD, Secretary.

POSTAL TELEGRAPHS.—In the House of Commons on Tuesday, the 27th instant, Dr. Cameron rose to call attention to the report of the Select Committee of 1876 on Postal Telegraphs; and to move that, in the opinion of this House, the time has arrived for adopting the policy of "increased telegraphic facilities and diminished charges" advocated by the Select Committee on Postal Telegraphs as "the true method of making the Telegraph Department remunerative." The hon. member was speaking in support of the resolution at ten minutes to seven, when, in accordance with the rules, the debate was suspended.

THE danger and inconvenience caused by the network of telephone wires over large towns was the subject of discussion at the Liverpool Town Council a short time ago. Alderman A. B. Forwood agreed that the wires were likely to prove a nuisance, and said that when in New York lately he counted in one place 500 wires over his head. The Town Clerk intimated that the Association of Corporations had taken up the question, and intended to draw the attention of the Home Office to the subject.

THE officers of the old British telegraph companies held their annual meeting on Friday last at the Salisbury Hotel, Fleet Street, when about twenty sat down to dinner under the presidency of Mr. Graves, the engineer-in-chief of the Postal Telegraphs, Mr. E. B. Bright, late secretary of the Magnetic Company, being vice-president. The absence of Messrs. H. Weaver and W. Andrews, through illness, was much regretted by all. Mr. W. T. Ansell, Mr. T. C. Bennett, Sir Charles Bright, Mr. Muirhead, Mr. G. Newman, Mr. W. H. Preece, Messrs. Ratcliffe, Mr. Sach, Mr. Sanger, Mr. Spagnioletti, and Mr. Lewis Wells were present.

THE £5 prize and silver medal for the Honours Examination in Technical Telegraphy, instituted by the City and Guilds Institute, has been awarded to Mr. H. M. Sayers, of the Central Telegraph Department, General Post Office. The second prize was gained by Mr. E. C. Pink, also of the same department.

IN the House of Commons on Tuesday, 20th ult., Mr. Walpole, in reply to Mr. D. Grant, said that owing to the risks incidental to the use of gas in the British Museum, the trustees had not seen their way to sanctioning the lighting up of the British Museum, so that it could remain open to the public till 10 p.m. The experience gained by the use of the electric light in the reading-room would not justify the extension of that system of lighting to other parts of the building, as there were no means at present of securing a sufficient number of separate lights to burn steadily and without interruption. The trustees would take the earliest opportunity that presented itself of giving effect to the wishes of the hon. member, when a means was discovered of doing so with safety.

TENDERS for lighting by the electric light several of the main thoroughfares of the City of London are to be asked for shortly. The area within which the lighting

will be tried is bounded by Cheapside and the Thames, from Blackfriars Bridge to London Bridge. The three bridges, London, Southwark, and Blackfriars, will be included in the scheme, and the main lines of light will stretch from Blackfriars, along both Queen Victoria Street and Ludgate Circus to Cheapside, through King William Street to London Bridge, with a cross line from Cheapside to Southwark Bridge.

It is proposed to light the Guildhall and London Institution libraries and reading-rooms by the electric light.

At a fête held at Paris on the 14th ult. the electric light was largely used. It was employed to illuminate the Gardens of the Tuileries, the upper part of Notre Dame, the Bourse, the dome of the Panthéon, Port St. Denis, and other buildings. The fête, being national, was celebrated all over France in the 40,000 communes or townships of the Republic, and the electric light was used in the provinces as well as in Paris. At Rouen a group of sixteen Siemens lights, of a power of about 100,000 candles, was placed on the top of the spire of the Cathedral.

A tower 200ft. high, with a powerful electric light at the top, is to be erected in the town of Holyoke, Mass., to illuminate the locality.

Mr. Trouvé has recently devised an improved form of Siemens armature for electro-motor or dynamo-electric machines. Instead of making the pole faces straight and parallel with the axis of rotation he gives them the shape of a snail, so that they pass before the magnet poles gradually. The result is stated to be very satisfactory.

The *Journal of Gas Lighting* says:—"Considerable importance was recently given by some English and French papers to the fact that the Paris *Salon* was to be lighted by electricity, and the asserted superiority of this light over gas for the illumination of paintings was accepted unquestioned by those who were too indifferent or too prejudiced to inquire very closely into the matter. We find, however, that a class of persons who must be admitted to have some slight knowledge of what is a good and what a bad light for a picture—the artists themselves—have protested against the use of the electric light at the *Salon*, this being stated to be the most unfavourable kind of illumination for effectively showing off their productions. The protest, however, comes rather too late. The agreement entered into with the Jablochkoff Company for the supply of the electric light has been carried out, and this system will, we suppose, remain in use until the end of the season, artistic protests notwithstanding. Again, when sober-minded, right-thinking people ventured to express a doubt as to the permanent adoption of the electric light by those shopkeepers in Paris who had been so ready to take it up as a novel and attractive, not to say startling kind of advertisement, their remarks were received by the worshippers of the rising luminary with all the impertinent contempt usually manifested towards opponents by converts to a new faith. Yet what do we find? The *Figaro*, whose office in the Rue Druot was one of the first buildings to be illuminated exteriorly by means of the electric light, has positively abandoned that system, and substituted for it two gas lamps similar to those used by the Paris Gas Company in the Rue du Quatre Septembre, where, by the way, only half the original number of burners are now lighted, and yet the general illumination of the thoroughfare is, we learn, if anything, a trifle better than that of the neighbouring Avenue de l'Opéra, where the electric light still reigns supreme."

A correspondent of the *Standard* says:—"That the Municipality of Havre have just entered into a contract with the Société Générale d'Electricité (Jablochkoff's patent) for lighting up by electricity the harbour and docks of Havre. This contract follows that between the Chemin de fer de l'Etat Belge, also with the Société Générale d'Electricité for lighting the Antwerp basins. In both cases the contract is for 10 years."

The *Atti dei R. Accademia dei Lincei*, fasc. 6, May, contains a paper by Dr. Maggi on the distribution of electricity in equilibrium on two parallel indefinite plane conductors, subjected to the induction of a point in the space included by them. Also a paper by Professor Macaluso, on the electric polarisation produced by metallic deposits.

M. Gostynaki has devised a new form of galvanometer, the principal advantage of which consists in the fact that direct proportionality is realised up to near 90°. The instrument has a continuous coil, *i.e.*, without slit for passage of an astatic system. A U-piece of aluminium wire, suspended by a cocoon fibre, supports two astatic systems of the same direction, crossed at an angle of 45°, and connected together. The double astatic system has a mirror attached to it, so that the movements are reflected on a demi-cylindrical scale having the suspension fibre for its axis, and projected on a small vertical sight placed behind the mirror. The proportionality has been proved in some 150 crossed observations.

How Quicksilver is produced.—The *Western Morning News* publishes the following account of a thunder-storm which occurred in the middle of last month:—"Reports from the rural districts to the north of Cork, and in the direction of Mallow, represent the storm as of a terrific character. At the telegraph office, at the railway stations, all the instruments were destroyed. A ball of fire struck some of the instruments and fell on the floor, breaking as it did so into small globules. One of these, on being examined, was found to consist of quicksilver."

Electro-Brass Plating.—According to the *Chemical Society's Journal*, M. J. J. Heoz uses the following bath, which differs materially from former formulæ:—84 grammes sodium bicarbonate, 54 grammes ammonium chloride, and 13 grammes potassium cyanide are dissolved in 2 litres of water. To render the bath active the sides of the vessel are covered with a sheet of brass, which serves as anode, whilst another piece of brass hangs in the bath and forms the cathode. The current is allowed to pass through the bath for one hour, when it is ready for use. It is better to employ cast brass. In order to tin directly on zinc the author uses the following mixture: 50 grammes sodium phosphate, 50 grammes salammoniac, 25 grammes sodium bicarbonate, and 25 grammes tin salt dissolved in 1 litre of water. Instead of sodium phosphate Rochelle salt may be employed.

Writing to *Nature*, Mr. F. T. Mott gives an interesting description of a curious electric phenomenon, observed on the 22nd June. He says:—"At about 4·30 p.m. this day a severe thunderstorm with a deluge of rain came up from the north-west and lasted about an hour. At 5·30 my wife was standing at the window watching the receding storm, which still raged

in the south, just over Leicester, when she observed, immediately after a double flash of lightning, what seemed like a falling star, or a fireball from a rocket, drop out of the black cloud about 25° above the horizon, and descend perpendicularly till lost behind a belt of trees. The same phenomenon was repeated at least a dozen times in about fifteen minutes, the lightning flashes following each other very rapidly and the thunder consisting of short and sharp reports. After nearly every flash a fireball descended. These balls appeared to be about one-fifth or one-sixth the diameter of the full moon, blunt and rounded at the bottom, drawn out into a tail above, and leaving a train of light behind them. Their colour was mostly whitish, but one was distinctly pink, and the course of one was sharply zig-zagged. They fell at a rate certainly not greater than that of an ordinary shooting star. I have never witnessed a phenomenon of this kind myself, but my wife is a good observer, and I can vouch for the trustworthiness of her report."

MR. JAMES JOHNSTONE sends to the *Edinburgh Daily Review* the following interesting account of the effects of a thunder-storm observed on the 7th ult. He says:—"On the 7th curt., about 4·15 p.m., the lightning struck the craig which is named on the plan of Edinburgh 'The Dasses,' which overhangs the Hunter's Bog on the east. The results are so extraordinary that they are worthy of notice in your columns. The rock struck is of the hardest basalt, commonly called whinstone. The lightning did not strike the sharp, serrated, front edge of the craig, as might have been expected, but, on the contrary, it struck the flat top covered with sod at a distance of 3 ft. from the present edge, and that must have been between 6 and 8 ft. from the edge before the accident; for the lightning detached several tons of the rock from the front of the craig, and sent six large masses of rock down into the Hunter's Bog. The largest of these measures 4 ft. long by 3 ft. broad and 1 ft. thick, but of irregular shape. On the edge of the craig the lightning detached a mass of rock, which now stands in a very precarious position. This large mass measures 4 ft. 9 in. long by 3 ft. broad and 1 ft. 4 in. thick. The top of the craig, a short distance from the front of it, is covered with a coating of angular pieces of basalt, and on the top of these a covering of sod. It was on the sod the lightning struck, and made a hole 2 ft. 6 in. long by 1 ft. 6 in. broad. The largest diameter of the hole is in a direction from N.W. to S.E. and the lightning continued its course in this direction, ploughing a furrow in the sod for a distance of 19 yards, the furrow diminishing in width as it receded from the original hole, where it measures 5 in. wide. These facts establish the direction in which the lightning came, and correspond with the observations of three gentlemen who were in a house on the west side of the Hunter's Bog, and saw the lightning pass across the Bog to the rock on the east side, namely from N.W. to S.E. In the *Times* of 14th October last, notice was given that a committee of scientific gentlemen had been appointed by insurance and other companies to investigate the effects of lightning with a view to providing the best means for protecting buildings, and a request was made that all persons who could furnish information on this subject would do so. In consequence of this notice I wrote a letter to the *Times* on 25th October, containing the following information, which it is important persons should know who wish to watch thunder-storms, and give the information asked. There are three kinds of thunder-storms. First, those that take place between clouds, the lightning flashing from cloud to cloud; second, storms in which the lightning comes from the clouds down to the earth; third, storms in which the lightning passes from the earth to the clouds. It is the two latter kinds of thunder-storms which affect the question of the protection of buildings. The damage done to them and to trees by lightning varies in a remarkable manner, according to whether the lightning went from the earth to the cloud or from the cloud to the earth.

"The lightning which struck the Dasses Craig has an important bearing with reference to the protection of buildings from lightning. The common theory is that lightning will always be attracted to and strike the highest or most prominent point in its vicinity. The Dasses Craig is near the bottom of the valley, bounded by Salisbury Craigs on the W. and S., and Arthur's Seat on the E. High land and prominent rocks surrounded this craig on all sides, and yet the lightning passed all these and decended into the valley to strike it.

"Another interesting fact. On placing a compass near the hole made by the lightning I found that the needle deviated from the N. to the E., and when the compass was in the hole, the needle stood at E.S.E., instead of N., proving that the rock was still powerfully electrical at the spot where the lightuing struck it. But, except in the vicinity of the hole, the craig did not affect the needle."

SOME researches by Herr Röntgen in the same line as those by Dr. Kerr, revealing a new relation between light and electricity, are described in the *Annalen der Physik*, No. 5; the methods were somewhat varied. Special attention was given to the direction of vibration of the light in the liquid, and the author's results seem in the main to confirm Dr. Kerr's views. Dr. Kerr got an effect with nitro-benzol only when a spark-interval was introduced in the connection of the one electrode with the conductor of the machine, giving a sudden discharge through the liquid. This Herr Röntgen considers due to the comparatively good conductivity of nitro-benzol; the spark discharge effects a brief but large difference of potential (not obtained in the other case), producing sudden luminosity in the field of vision. But Herr Röntgen obtained the same effect with all the badly-conducting substances he examined; it was only of longer duration. A welcome method is thus afforded for examining comparatively good conducting liquids as to electro-optic properties, and Herr Röntgen thus demonstrated, for glycerine, sulphuric ether, and distilled water, an influence of electricity on the transmitted light. The author offers (doubtfully) a different hypothesis of the phenomena to that of a direct action of electricity on the light vibration.—*Nature*.

ACCORDING to some experiments made by Professor Quincke, dielectrics undergo either expansion or contraction, according to the nature of the substances; thus, in most cases, the result of surface electrification is to produce a minute expansion, but fatty oils and resins contract under similar circumstances. Herr Quincke applies his measurements to explain the phenomena observed by Kerr of the double refraction of light exhibited by dielectric media when under electrostatic strain; and he shows that the optical effects in the two classes of media are opposite in character.

ONE YEAR'S PROGRESS.—The American Union has issued a handsome map of its lines and connections, dated May 15th, 1880. On the back it is stated that the company was "organised under the general laws of the State of New York, on May 15th, 1879.

"Within one year from the date of its organisation, notwithstanding the most determined opposition, which

has in every instance failed, the American Union has erected over 25,000 miles of new wire, leased the lines of the Dominion Telegraph Company of Canada, made an exclusive contract with the new French Atlantic Cable Company, and established connections with the lines of many important railroad companies, as shown on the within map, giving it in all a system of lines, in the United States and Canada, of 50,000 miles of wire, and 1,550 offices, and also cable communication with Europe. The American Union is the strongest opposition telegraph company ever established in America. As its lines have reached the various larger cities they have been opened for business at the prevailing rates, and even under these circumstances the result has been most liberal and emphatic. The management of the company therefore feels assured of its success; and, with the promise of reduction of rates as the extension of the system will from time to time warrant, relies upon such patronage as will be profitable to the company, and emancipate the public from the exactions of a monopoly."—*Operator.*

SOUTH AUSTRALIA, Victoria, and New South Wales have agreed to a uniform charge of 3s. per 100 words on all press telegrams sent between the three colonies by day or night.

THE Commission for the construction of the Trans-Saharan Railway has determined that this great work shall be preceded by the establishment of a telegraph line connecting Algiers with St. Louis in Sengal *via* Timbuctoo.

A NEW ATLANTIC CABLE.—The Telegraph Construction and Maintenance Company's steamships *Seine*, *Kangaroo*, and *Scotia*, have sailed from the works at Greenwich with the sections of the new cable for the Anglo-American Company.

THE first number of a new scientific periodical, entitled *Les Découvertes*, was published in Paris on the 22nd ult. The numbers will appear weekly, and will give full illustrated descriptions of the inventions and discoveries of the day.

BY means of an improved telephone the Adelaide Post Office chimes have been clearly heard at Port Augusta, a distance of 240 miles.

City Notes.

Old Broad Street, July 28th, 1880.

EASTERN TELEGRAPH COMPANY, LIMITED.—The sixteenth ordinary half-yearly meeting of the proprietors of this company was held July 15th, at the City Terminus Hotel, Mr. J. Pender, M.P., in the chair. The chairman, in moving the adoption of the report (*see* TELEGRAPHIC JOURNAL, p. 251, previous issue), said that the net revenue for the six months ended the 31st March, 1880, amounted to £291,194, against, in the half-year of 1879, £235,077. Of this increase £4,000 was attributable to telegrams sent by the Cape line opened for traffic on the 29th September last. Their receipts from this source were now at the rate of from £19,000 to £20,000 per annum, their own estimate having been, when they proposed the Cape cable, that they would get £15,000. They were already getting £20,000, and he did not think he was expressing a too sanguine opinion when he said that when they next met they might look forward to an income from this source of £25,000 (hear, hear). They had also been able to show a substantial increase throughout their whole system. There was a sum of £4,850, being a quarter's dividend of their holdings in the South African Company after having written off £1,000 in reduction of cost. The South African Company was paying six per cent., and there was evidence that it would probably do better. The ordinary expenses were £68,637, against, in the corresponding half-year, £67,953. These figures, however, included the sum of £1,935 for depreciation of cable stores, which did not appear in the charges for 1879. Had it not been for this and exceptional expenses for supplying split pipes for the Gibraltar land line—about £1,000—the expenditure for the half-year would have been considerably less. The extraordinary expenses amounted to £19,896, against £23,935 in the corresponding half-year. This item included expenses of several ships which had been despatched to repair cable. They had carried to general reserve £78,205, against £16,876 in 1879. This made the total reserve £287,569. Six months ago he gave a detailed account of the position of the company, showing the whole working and the probable future profit. To that statement he had very little to add, further than that the cables were all in good order, and that the staff, so far as efficiency was concerned, had shown much improvement. The Cape cable, he was glad to say, had improved more than they had expected. Their calculation was something like 20 messages per day, and the average had doubled that amount. Therefore there was every hope that it would prove better than they had any reason to expect. As to the Algiers traffic, he thought they had not been treated fairly by the French Government, but the cable was useful in developing Egyptian and Eastern traffic. Egypt was the stepping-stone to India, Australia, and New Zealand, and that was to them a most important station. He was hopeful, however, that when the Government of France became more settled, they would be able to deal with them on fair and reasonable terms. As to the question of dividing, he said that they were carrying forward this half-year £75,000, against £16,000 last half-year. His idea of perfect safety was that they ought to carry forward £100,000 a year to reserve until the fund arrived at a respectable figure. He thought that it would be desirable to pay the 5 per cent. permanent dividend, and then, after they were able to pay the £100,000 to the reserve, they might divide the balance in the form of a bonus. By adopting this course, he thought that the value of their property would be largely increased. The Marquess of Tweeddale seconded the motion. Major Leslie moved, as an amendment, than an addition of sixpence per share should be paid in the shape of dividend for the half-year, which would give them a dividend at the rate of 6 per cent. per annum. The effect of this, he thought, would be to make their shares more valuable in the market. The chairman stated that, according to the articles of association, the amendment could not be received. He did not desire to be bound to 6 or 7 per cent., but that the shareholders should have the entire surplus divided as bonus. After some discussion, the original motion was carried with only one dissentient, and the directors were unanimously authorised to assist the servants of the company in insuring their lines, provided the amount paid from the revenue of the company did not amount to more than one-half of the insurance premiums. After further discussion, the action of the board in purchasing, on behalf of the company, the 19,000 fully-paid shares of £10 each of the Eastern and South African Telegraph Company, was approved.

CUBA SUBMARINE TELEGRAPH COMPANY.—The half-yearly general meeting of this company was held on July 21st at the offices, Old Broad Street, under the presidency of Mr. T. Hughes, Q.C. The chairman, in moving the adoption of the report (see TELEGRAPHIC JOURNAL, p. 252, previous issue) and accounts, stated that the traffic receipts were £1,000 in excess of those of the corresponding period of last year, which was an increase of 6½ per cent. It had been stated that the increase ought to be 10 per cent., but he did not know that that had been the experience of many companies of late years. He (the chairman) thought, at any rate, that they would agree that the increase they had had was satisfactory in these times. After speaking of the increase of dividend, and the necessity of carrying forward a good amount, he referred to the breakage in the Cienfuegos-Santiago section of the cable, and said that their manager was now engaged in repairing it. Mr. A. F. Low seconded the motion, and it was carried unanimously. The dividend was next declared, and the retiring director and auditor were afterwards re-elected. A vote of thanks to the chairman and directors closed the proceedings.

THE DIRECT UNITED STATES CABLE COMPANY, LIMITED.—The report of the directors for the six months ending 30th June, 1880, to be presented at the sixth ordinary general meeting of the company, states that the revenue for the half-year, after deducting out-payments, amounted to £82,149 0s. 3d. The working and other expenses for the same period, including interest on debentures, and income-tax, &c., amounted to £22,863 13s. 9d., leaving a balance of £59,285 6s. 6d. as the net profit for the half-year; making, with £15,677 16s. 7d. brought forward from the previous half-year, a total of £74,963 3s. 1d. Three quarterly interim dividends of 1¼ per cent. each, amounting to £45,532 10s., have been declared and paid at the usual times during the financial year, and a final dividend of 5s. per share is now proposed, making, with the three interim dividends, 5 per cent. for the year, being a total distribution of £60,710. The appropriation of the above balance of £74,963 3s. 1d. on the revenue account is thus shown:—Interim dividend for quarter ending 31st March last, £15,177 10s.; final dividend now proposed, £15,177 10s.; carried to reserve fund, thereby increasing it to £175,000, £22,847 14s. 3d.; carried forward to next account, £21,760 8s. 10d. The cables are now, and have been during the past year, in good working order. The cable of the Compagnie Française du Télégraphe de Paris à New York having opened for traffic, the English companies have met the competition thus forced upon them, by the reduction of rates. The application of the Duplex system has largely increased the carrying power of the company's cable. The directors have had under consideration the question of establishing an assurance fund for the company's staff on the same principle as that recently sanctioned by the shareholders of the Anglo-American and Eastern Telegraph Companies—viz., to enable the staff to secure the payment to themselves of a limited sum at a given age, or to their families in case of death, the company paying one-half the requisite premiums. The total cost to this company would not exceed £1,000 per annum. The directors recommend this measure to the shareholders as being one calculated to promote the efficiency of the service by encouraging the staff to remain permanently attached to the company. A resolution empowering the directors to carry out the above arrangement will be submitted to the meeting. Pursuant to the provisions of the articles of association two of the directors—viz., William Ford, Esq., and C. J. Günther, Esq., retire by rotation, and being eligible, offer themselves for re-election. Mr. J. G. Griffiths and Mr. Joseph Sawyer, the auditors, retire pursuant to the articles of association, and offer themselves for re-election. The meeting will be held at the City Terminus Hotel, Cannon Street, on the 29th July, at 12 o'clock noon.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—The half-yearly general meeting of this company was held on the 20th inst., at 38, Old Broad Street. The chairman (Sir Daniel Gooch) said: Gentlemen, as the object of this meeting is more to give you a short account of the work which is in hand than for anything else, I will state shortly to you what we have done during the last half-year. We have laid 120 miles of cable in New Zealand. We have laid 550 miles of the Hong-Kong and Manila line; we have made a contract with the Anglo-American Company, just about the time of our last meeting, for laying 1,500 miles of cable, with the view of repairing the 1866 cable of their system, and also to lay a new cable between Newfoundland and Nova Scotia, about 290 miles long. The ship with the latter portion left on the 11th inst., and I hope she is on the ground now. The *Scotia* will leave before the end of the month, and the *Kangaroo* with the remaining portion of the Atlantic cable, and we hope in a very short time these services will be successfully completed. I may state that Captain Slocomb is in charge of the expedition, and his experience and care in these matters give us great confidence that everything will go well. Then we have sent a ship, just started—a ship with a small house and land lines that we had to complete the Cape cables, and when those are finished that is the last work at the Cape we have got to do. That is all I have to say with regard to the work done during the half-year. The work that we have got in future we do not know much about. We are negotiating now for some cable, but it is as yet indefinite, and in future we are dependent a little on what orders may come in. After remarks from Mr. Abbott and others, and the usual votes of thanks having been accorded, the proceedings terminated.

THE GLOBE TELEGRAPH AND TRUST COMPANY, LIMITED.—The report of the directors to be presented to the seventh ordinary general meeting, 30th July, 1880, states that the net revenue of the company for the year, after deduction of expenses, amounts to £169,587 13s. 7d., which, with the balance of £973 14s. 1d. brought forward, makes a total of £170,561 7s. 8d. From this amount there has been distributed in interim dividends the sum of £119,887 14s., and the directors have written a further sum of £1,000 off the preliminary expenses account, leaving an available balance of £49,673 13s. 8d. The directors now recommend payment of a final dividend for the year of 3s. per share on the preference shares, and of 3s. per share on the ordinary shares (making, with the former distributions, a total dividend for the year of 6 per cent. upon the preference and 4½ per cent. upon the ordinary shares), carrying forward a balance of £841 12s. 8d. The directors have issued 4,000 preference and 4,000 ordinary shares of £10 each, in exchange for 4,000 £20 shares of the German Norwegian Submarine Cable Company. This company was formed in Berlin in 1879, with a capital of £87,500, for laying a cable between Germany and Norway, upon the basis of a subvention of £7,000 per annum from the German Government, with a share in the tariff receipts. The capital is to be redeemed by an amortization fund and yearly drawings. The dividend runs from the 1st January last, and is estimated to be not less than 6 per cent. per annum, although no payment will be received in time to appear in this year's accounts. Twelve

shares have since been drawn and paid off at par in accordance with the statutes. Exchanges have also been made for the following, viz.:—115 Submarine Cable Trust £100 certificates, 1,600 Eastern Extension £10 shares, 100 Eastern Telegraph £10 shares, and 374 Indo-European £25 shares. The 39 5 per cent. debentures of the Western and Brazilian Company of £10 each, issued at £8, have been paid off at par. In conformity with the articles of association, Mr. John Pender, M.P., and Sir James Anderson, two of the directors, retire; but, being eligible, they offer themselves for re-election. The auditors, William Newmarch, Esq., F.R.S., and John George Griffiths, Esq., also retire at the meeting, and offer themselves for re-election.

Submarine Cables Trust.—The report of the trustees to be presented to the ninth ordinary annual meeting of the certificate holders, to be held at the offices of the Trust, 66, Old Broad Street, London, on the 30th day of July, 1880, states that the accounts were prepared and audited to show the actual receipts and disbursements during the twelve months ending April 15th, 1880. As the dividend which had accrued on the shares of the Eastern Extension Telegraph Company to 31st December, 1879, amounting to £1,696, was not paid until April 21st, it is not included in the revenue account now submitted, but will be brought to the credit of the current financial year. The revenue for the twelve months to 15th April, 1880, including a balance of £11,913 15s. 4d. brought from last year's accounts, amounted to £35,046 6s. 6d. The expenses of the trust absorbed £1,420 14s. 11d., leaving an available balance of £33,625 11s. 7d. From this sum three coupons have been met amounting to £31,086, carrying forward a balance of £2,539 11s. 7d. The certificate holders will remember that in April last year an injunction was granted by the Master of the Rolls, restraining the trustees from dealing with the funds of the trust except under the direction of the Court. In January last a decree was made ordering the trust to be wound up. Against this action the trustees appealed, and a decision has just been given by the Lords Justices reversing the decree of the Master of the Rolls. The securities held by the trustees are precisely the same as on the date of the last report. It will be observed that about 18 per cent. of the certificates have been already redeemed. The meeting will have to elect auditors for the current year. Mr. William Newmarch, F.R.S., and Mr. J. G. Griffiths (Messrs. Deloitte, Dever, Griffiths & Co.) retire, and, being eligible, offer themselves for re-election.

Mr. G. Von Chauvin has resigned his position as general manager of the "Compagnie Francaise du Telegraphe de Paris à New York." As the directors of that company still endeavour to maintain a 2s. tariff in the face of their competitors' rate of 6d. per word, it seems to us no other course was open to one so experienced in such matters as Mr. Von Chauvin.

The following are the final quotations of telegraphs.—Anglo-American Limited, 62½-63; Ditto, Preferred, 92-93; Ditto, Deferred, 35¼-35¾; Black Sea, Limited, —; Brazilian Submarine, Limited, 8⅝-8⅞; Cuba, Limited, 10-10½; Cuba, Limited, 10 per cent. Preference, 16½-17½; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11¼-11¾; Direct United States Cable, Limited, 1877, 12-12½; Scrip of Debentures, 102-104; Do., £50 paid, 1-3 pm.; Eastern, Limited, 9⅜-9⅝; Eastern 6 per cent. Preference, 12⅛-12⅜; Eastern, 6 per cent. Debentures, repayable October, 1883, 103-106; Eastern 5 per cent. Debentures, repayable August, 1887, 104-107; Eastern, 5 per cent., repayable Aug., 1899, 105-108; Eastern Extension, Australasian and China, Limited, 9⅜-9⅝; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 102-104; Ditto, registered, repayable 1900, 102-105; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 100-103; Ditto, ditto, to bearer, 100-103; German Union Telegraph and Trust, 9-9⅛; Globe Telegraph and Trust, Limited, 6⅜-6⅝; Globe, 6 per cent. Preference, 12¼-12½; Great Northern, 9⅜-9⅝; Indo-European, Limited, 23½-24½; London Platino-Brazilian, Limited, 4¾-5¼; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10⅝-11; Reuter's Limited, 9½-10½; Submarine, 245-255; Submarine Scrip, 2⅛-2⅜; West Coast of America, Limited, 2¼-2½; West India and Panama, Limited, 1⅛-1¼; Ditto, 6 per cent. First Preference, 7⅛-7⅜; Ditto, ditto, Second Preference, 6¾-7¼; Western and Brazilian, Limited, 6⅛-6⅜; Ditto, 6 per cent. Debentures "A," 100-103; Ditto, ditto, ditto, "B," 97-100; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 33¾-34¼; Ditto, 6 per cent. Bonds, 105-108; Ditto, Second Bonus Trust Certificates, 3⅜-3⅝; India Rubber Company, 15-15½; Ditto 6 per cent. Debenture, 105-107.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
June, 1880 ...	*	a 10,882	2,700	1,277	*	42,522	29,100	22,520	... ...	*	... ...	a 8,916	4,017
June, 1879 ...	45,000	11,021	2,425	1,025	15,000	36,635	26,485	19,618	... ...	10,661	725	9,379	3,970
Increase	... ...	... ...	275	252	... ...	5,887	2,615	2,802	... ...	... ...	... ...	... ...	47
Decrease	... ..	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...

* Publication of receipts temporarily suspended.

a Four weeks compared with thirty days of June, 1879.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 181.

INSULATING MATERIALS.

PERHAPS less progress has been made in the invention of insulating materials than in any other branch of telegraphy. Plenty of skill and science has been brought to bear upon the subject, as numerous patents of wonderful and fearful compounds testify; but the evidence of the work done in this direction has yet to be seen. Certain it is, that of all the products which have been invented, and which their inventors have felt confidence in, not one has been able to compete, with anything like success, with either gutta-percha or india-rubber, especially with the former.

Ever since its first discovery, gutta-percha has continued to prove the very best of all insulating materials in every respect, that is, both mechanically and electrically, whilst its durability for a lengthened period, under ordinary circumstances, is unquestionable.

The enormous quantities of gutta-percha which have been consûmed for telegraphic purposes have naturally caused the price to increase considerably, whilst the manner in which the raw material is obtained, without thought of the scarcity which may ensue from the destruction of the trees from which the substance is drawn, is likely to cause the price to go still higher. It is possible that a systematic cultivation of the trees from which the percha is obtained may be attempted at some future date, to the great improvement of the quality of the raw material, but it would take years for all the destruction done to be repaired.

A great question of the day is cheap telegraphy, and the questions involved in enabling this desideratum to be effectually carried out are very numerous. Fast speed telegraphy is one of these. The latter question has been practically solved as regards aërial land lines; there is no difficulty in getting an amount of work out of a single land line which could only be carried on by several cables worked at the ordinary slow speed. In the case of aërial lines inductive embarrassment is but slightly felt; in the case of cables it is the one cause which keeps down the speed, and as far as can be seen, it can only be got over by an increased thickness of dielectric. This latter means greatly increased cost, and the high price of gutta-percha would be a great stumbling-block if the question of manufacturing a cable capable of a high speed of working were considered. The numerous experiments which have been made with the object of finding a cheap substitute for gutta-percha have been so unsuccessful that the public would look with great distrust upon any attempt to construct a long ocean cable of any new and, to a great extent, unproved material, even though the possible advantages were considered to be ever so great. Such an attempt, although possibly a success, would have very great chances of turning out a costly failure, in which most, if not all, of the capital invested would be lost. For underground work some new and cheap insulating material would have very much better chances of success, and, as there is an unquestionable tendency to abandon open in favour of underground wires, a really good and cheap material would prove a very profitable invention to the discoverer.

As regards the insulating property of the material for coating wires, we are inclined to think that a great deal too much importance is attached to the high degree of insulation which the substance is required to have; an insulation of 100 megohms per mile is amply sufficient for cables of a moderate length, provided this comparatively low value is due to the nature of the material and not to a defect in it. A cable with an insulation of 1,000 megohms per knot is, as regards its working capabilities, no better than one which has an insulation resistance of only 100 megohms per knot, but to such a degree of perfection has the manufacture of the insulating material been brought that the fact of the insulation being low is a conclusive proof of a defect. If a durable, sound, and cheap dielectric were discovered whose insulating properties were only a tenth of that possessed by gutta-percha, but yet whose mechanical strength was equal to the latter substance, it would be a very great mistake to reject it because it does not possess the property of very high insulation, since this is really of no practical value.

SECONDARY BATTERIES WITH CARBON ELECTRODES.

By SAUVAGE HENRI, Commis Principal des Télégraphes at Evreux.

(*Continued from page* 261.)

As in the piles with carbon and zinc electrodes, so in the couples with two carbon electrodes, it is the hydrogenised electrode which must be of large dimensions; the oxygenised electrode can be much smaller than the other. If an experiment is made with an element formed by means of a plate of carbon set in a compartment separated by a thin

wooden division of a size relatively large to the carbon grains, a secondary current of longer duration is obtained than when the hydrogen has been developed on the large electrode, and on the contrary, a current of short duration when the hydrogen has been developed on the small plate; in the first case the current only falls to 85° in fifteen minutes on the circuit being closed immediately after charge; in the second case it falls to 9° in two minutes. These results are absolutely the same if the plate of carbon be lifted out and exposed to the air, and then placed in the element after having been wiped. Still more, if at the moment when this system gives a deflection of 110° a carbon pencil which has never been used be substituted for the oxygenised plate, a current of 20° will still be observed in the same direction, which descends to 10° in one minute. When, if for this electric light pencil a plate of platinum was substituted with about the same surface, it was noticed that a deviation of 20° falling to 15° in one minute was obtained. The electric light pencil on being replaced gave 8°, and the platinum in its turn 15°, and so on.*

M. Planté remarks that the hydrogen occluded in the mass of the negative plate unites with the oxygen, not only in the interior of the oxygenised plate, but also in the water which surrounds the plate.

A last remark must be made on the subject of voltameters or secondary elements with carbon electrodes. Just as it has been shown in a preceding examination of the *rôle* which carbon plays in batteries (*Annales Télégraphiques*, July—August, 1875), that the æration of the hydrogenised carbon is necessary for the depolarisation of the electrode receiving the hydrogen, so in this case this æration of the hydrogenised carbon is in opposition to the strength and the duration of the secondary current. In order to verify this, a syphon was arranged to carry off a part of the water immediately surrounding the hydrogenised carbon, and to put it back again at will. The same element which, covered with water, gave then a current of 90° on the 20th day, was three-quarters emptied of its water after a new charge; after two days' æration it only gave 92°; the water drawn off was then replaced, and the deflection was still 92°, the rest not having changed this. The part remaining bare had alone kept its hydrogen and its electrical energy, if one may so call this latent power.

In the primary batteries with carbon electrodes, carbon in powder is known to be objectionable in consequence of the difficulty with which the absorbed hydrogen is disengaged; the same difficulty is an obstacle to the employment of this powder in secondary batteries. An element thus constructed caused the charge current from 5 Calland cells to fall to 35° in 1 hour, and to 13° in 7 hours; it finally gave only 10°; this secondary current recovered its power to 36° by long rest, and fell on the circuit being closed, from minute to minute, to 26°, 24°, 22°, 21°, 20°, 19°, remaining at 19° for 3 minutes, and then falling slowly more and more.

From these experiments, incomplete as they were, the following conclusions could be drawn:—

The carbon employed as the positive conductor to decompose the water broke itself up into fragments so finely divided that they remained in suspension, and were practically dissolved in the water that passed through the filter.

This breaking up is not an inconvenience to consider in secondary batteries when electrodes composed of a large number of broken fragments are employed, and when the duration of the charge current is not uselessly prolonged.

It appears demonstrable that the employment of carbon in secondary batteries has several practical possible applications, in the same way as it was shown in 1875 that it could be advantageously employed in primary batteries. The conditions of the employment are the same from the point of view of development and division; they are inverse from the point of view of æration.

The secondary current of the carbon elements appears to be due simply to the reaction of the hydrogen gas occluded in the pores of the mass of grains of the one of the electrodes on the oxygen which is occluded in the other carbon, or which is found in the water either in the form of oxygen or of carbonic acid. The secondary current of the carbon couples appears to be less intense than that on lead couples of the same surface.

It lasts much longer.

There is no necessity for a "formation," which is necessary in the Planté element, and which is obtained so slowly. If the two electrodes are equal, the direction of the charge current is immaterial; it is only important that the charges be always made in the same direction.

Finally, there would undoubtedly be no advantage in employing carbon electrodes if those of lead already peroxydised and sufficiently "*formed*" can be had. For it would be impossible to obtain couples as handy as those of M. Planté, and of sufficiently large surfaces in a restricted space. But in the absence of such sufficiently "*formed*" plates, large electrodes of compressed carbon could be set up and charged at but little expense, and would give, when required, a strong power, and one of very long duration.*

The gas carbon can be obtained in abundance from the gas works, and the elements thus formed do not require any preliminary preparation or any care in setting up; a simple frame of thin wood is sufficient to keep the plates apart.—*Annales Télégraphiques.*

A NEW POWERFUL AND CONSTANT BATTERY WITHOUT ACID.

By EMILE REYNIER.

THE problem of the abundant and economical production of electricity in the arts has been solved in a satisfactory manner by magneto-electric machines; but in establishments where motive power cannot be obtained, and which are very numerous, recourse

* The part of the first plate immersed exposed ·90 square metres of surface, and ·20 cubic metres of volume; that of the carbon measured ·123 metres.

* The duration of the discharge current is, in fact, very long indeed; the secondary carbon elements only fell to 145° in 0 minutes, and to 109° in 7 minutes: the circuit being closed, the secondary lead elements fell to 102° in 5 minutes, and to 44° in 9 minutes.

must be had to nitric acid batteries, the inconveniences of which are well known.

Many persons have endeavoured to obtain batteries which are both powerful and constant, and which at the same time do not give off disagreeable fumes. Up to the present, no batteries have fulfilled all these conditions, and the Grove and Bunsen couples have continued to be employed in spite of the disagreeable and hurtful fumes which they give off, and in spite of their expensive nature and the trouble they give in requiring to have their zincs amalgamated, their contacts cleaned, &c., operations which must be repeated each time the battery is set up.

I have tried, amongst many other things, to get rid of these inconveniencies, and to a very great extent have succeeded by means of my new battery, of which the following is an account.

The zinc of this new battery is plunged into a solution of caustic soda, the negative electrode, which is of copper, is depolarised by a solution of sulphate of copper, separated from the alkaline solution by a porous cell. The couple thus arranged is constant. Its electro-motive force is considerable, being from 1·3 to 1·5 volts, according to the degree of concentration of the solutions.

The solutions of soda and sulphate of copper have a medium conductivity; I have diminished their resistance by the addition of certain selected salts. On the other hand, I have notably reduced the resistance of the porous chamber by employing for that purpose parchment paper, which has already been employed for the same object by M. F. Carré.*

I superpose several leaves of this paper in order to reduce the permeability, and I make my porous vessels in the form of a flat rectangular prism, so that relatively large surfaces can be given to the electrodes.

These prismatic vessels are obtained without cementing or a joint by the following method: in the middle of the leaf of parchment paper of which the vessel is to be constructed the base of the prism is sketched; on each of the sides of this polygon, and at a distance equal to the height of the vessel, parallel lines are traced, which together form a polygon larger than the one cut out. Finally, the vessel is formed by folding the portions of the septum placed outside the geometrical development of the prism. These folds are folded close one over the other, so that those faces of the vessel are made least permeable which are so required.

Fig. 1 shows in perspective the rectangular porous vessel; fig. 3 shows the paper leaf for forming the same, laid out flat, and the one set of fold creases indicated by the thick and the other set by the thin lines.

The method of manufacture is applicable to prismatic vessels of any form whatsoever. For example, an octagonal vessel (fig. 2) can be fashioned by means of the development indicated by fig. 4.

Let me call attention in passing to the use which chemists could make of such vessels in dealing with experiments on *osmosis*.

The zinc (fig. 5) and the copper (fig. 6) of the battery are cut out, without waste of the metal, from the ordinary commercial sheet zinc; the connecting lugs are formed out of the piece itself, which offers the double advantage of no soldering being required and of a passage for the circulation of the liquid being given. The copper is placed outside the porous vessel, as shown by fig. 7.

The initial electro-motive force of the ordinary zinc and copper couple, immersed in my solutions, is 1·47 volts. It falls to 1·35 volts after being on short circuit continually. The resistance is ·075 ohms for the pattern here represented, the height of which is ·20 metres, and the capacity 3 litres.

In order to determine the rank which this battery should occupy in the series of couples with which it was compared, I have drawn up a list showing for each their electro-motive force, E, their internal resistance, R, and the *outside work done*, T, expressed in kilogrammes per second, this latter value being calculated by the expression:—

$$T = \frac{E^2}{4\,R \times 9{\cdot}81}.$$

By dividing the values in kilogramme metres by the mechanical equivalent of heat, the values of the work done can be obtained in calorics (gramme degrees), which values are also given in the following table:—

Name of Battery.	Constants.		Work.	
	E, In volts.	R. In ohms.	T. In kilo-metres.	T. In calorics.
Bunsen: ordinary form; height, ·20 metres ...	1·80	·24	·344	·796
Bunsen: Ruhmkorff pattern; height, ·20 metres	1·80	·06	1·378	3·189
Daniell: round form; height, ·20 metres ...	1·06	2·80	·010	·023
Daniell: Thomson's tray form; electrodes 12 decimetres square ...	1·06	·20	·143	·331
Daniell: Carré pattern; height, ·60 metres ...	1·06	·12	·238	·551
Reynier: rectangular form; height, ·20 metres	1·35	·075	·619	1·440

It can be seen that my new rectangular couple, ·20 metres in height, surpasses in power the largest sulphate of copper and sulphate of zinc batteries; it is about twice as powerful as the ordinary round Bunsen, and is only exceeded by the rectangular Bunsen, Ruhmkorff pattern. The zinc is not amalgamated, nevertheless it is not attacked on open circuit by the alkaline liquid in which it is immersed; consequently the weight of zinc consumed is perfectly proportional to the work done, and gives exactly the quantity of current generated.

The new battery, as has been before stated, does not emit any fumes, consequently it contains after work all the substances employed, altered in nature, but without loss. It is possible, therefore, to regenerate these products, that is to say, to bring them back again almost to their original state. In order to do this, the exhausted liquids must be traversed by a quantity of electricity rather greater than that given out by the pile, by dissolving the

* *Comptes rendus de l'Académie des Sciences*, vol. lxvi., p. 612.

FIG. 1.

FIG. 2.

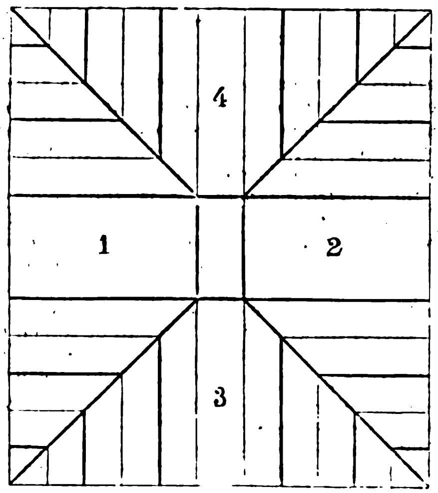


FIG. 3.

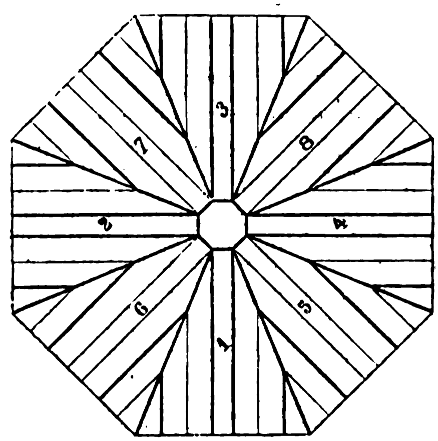


FIG. 4.

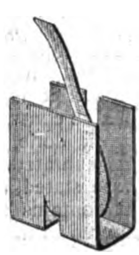


FIG. 5.

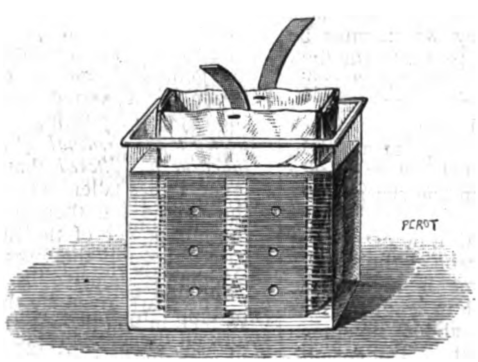


FIG. 7.

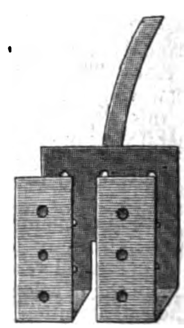


FIG. 6.

copper deposited and depositing the zinc dissolved.

If magneto-electric machines are used for producing the electricity necessary to renew the battery, the renewal is done at the expense of motive power. Economically produced by the aid of powerful machines, the electricity becomes stored up in the liquids, regenerated to the state of energy which is disposable and portable. This indirect transport of electricity generated by machines would be, in most cases, more practicable and more advantageous than the direct transmission by cables.

Actually the renewed liquids are not employed, the new battery offering as it does a notable economy of material and labour over the nitric acid couples. As to the industrial realisation of the process of regeneration, which should render my battery economically applicable to small electric motors and to domestic lighting, it is yet hindered by certain difficulties foreign to the art, which will, I trust, be overcome eventually.—*La Lumière Electrique.*

ELECTRIC MINE EXPLODERS.

SIEMENS' APPARATUS.

The magneto-electric exploder.

THIS apparatus (fig. 1) consists of a number of powerful *permanent* magnets, between the poles of which there is an ordinary Siemens' armature. When the armature rotates, its magnetism is reversed, and the alternating positive and negative currents generated are reduced to a common direction by means of a commutator, similar to that shown at *c* in fig. 3. One complete revolution of the handle causes the armature to revolve thirteen times, and at each turn of the armature two currents of opposite direction are induced in the wire coil, or a total of twenty-six currents for each revolution of the handle. The apparatus, which consists of an armature (as above described) and six permanent magnets, has been specially designed for blasting operations, in which only a small number of shots are to be exploded. It fires twelve Abel's fuses in single circuit simultaneously and with certainty. The working parts of the exploder are inclosed in a teak-wood case, fitted with straps and two terminals for the leading wires. The terminals are short-circuited by a firing-key, which must be depressed before the current can pass into the line. The handle can be taken off and placed in the side of the case. The outer dimensions are 10" × 7" × 7", the total weight only 22 lbs. The length of spark which this exploder will give is $\frac{11}{5000}$ of an inch. A general view of the apparatus inclosed in its case and connected to fuses placed in the charges in a mass of rock is shown by fig. 2.

A larger form of apparatus, with nine permanent magnets, is of the same construction as the smaller one, but the electro-motive force is higher, the spark being about $\frac{20}{5000}$ of an inch in length. This apparatus fires simultaneously about seventeen Abel's fuses in single circuit. Dimensions, 10" × 8½" × 7". Total weight 29 lbs.

The dynamo-electric mine exploder.

This instrument consists of an electro-magnet and an ordinary Siemens' armature, which, by the turning of a handle, is caused to revolve between the poles of the *electro*-magnet. The coils of the latter are in circuit with the wire of the revolving armature, and during rotation the residual magnetism of the soft iron electro-magnet cores at first excites weak currents, which pass into the coils, increasing the magnetism of the core, thus inducing still stronger currents in the armature-wire. This accumulation by mutual action goes on until the limit of magnetic saturation of the iron cores is reached.

By the automatic action of the machine the powerful current so produced is sent into the leading wire to the fuse. The fuse being practically either an interruption of the circuit, or a great increase in its resistance by the interposition of a badly-conducting substance, the consequent action is that either an electric spark passes between the interrupted portions of the conductor or the piece of bad conductor is highly heated, causing ignition of the explosive substance contained in the fuse. Fig. 3 is a diagram of connections of the apparatus.

A is the revolving armature, on the axle of which is a pinion, driven by a wheel which is turned by the handle at the end of the machine. The axle of the driving wheel is geared into the cam wheel, S, so that the latter makes two revolutions for every revolution of the former. F F are the pole pieces of the electro-magnets. *c* is the commutator, by means of which the currents of alternate direction generated in the armature are caused to flow only in one direction through the coils, E E, of the electro-magnets. After every revolution of S, a tooth of the lever, D, falls into a notch cut in S, and causes the end of the lever to be forced by the spring beneath it into contact with the screw, *d*, thus breaking the short circuit hitherto existing in the instrument, and causing the current to pass to line by the terminals, *e e*, to which the line-wire is connected, and through the fuses, *f f f*.

These dynamo-machines are constructed of two kinds, viz. :—

(1) The dynamo-electric *tension*-exploder, and
(2) The dynamo-electric *quantity*-exploder.

The large tension-exploder, which is the machine just described, has its coils, both of the armature and the electro-magnets, wound with fine wire to a total resistance of 2,000 to 2,500 Siemens' units in about 17,000 windings. Upon causing the armature to revolve, currents of *high electro-motive force* are generated, and an electrical spark passing between the separated conductors in the fuse inflames the explosive priming. *The line wires should be connected to the terminals of the exploder directly after the machine has clicked*, that is, when the tooth of the lever, D, has fallen into the cam, S. Two turns of the handle are then required in order to develop the full power of the machine before the current passes through the fuses. The total weight of the machine is about 59 lbs. Dimensions, 15" × 15" × 7".

The spark given by the large exploder is $\frac{200}{5000}$ of an inch in length, and the apparatus fires simultaneously about 50 Abel's fuses in single circuit.

The small tension-exploder is of the same construction as the large one, but weighs only 35 lbs.; it is placed in a leather knapsack for transport. The spark given by the small exploder is $\frac{150}{5000}$ of an inch in length. This apparatus fires simultaneously

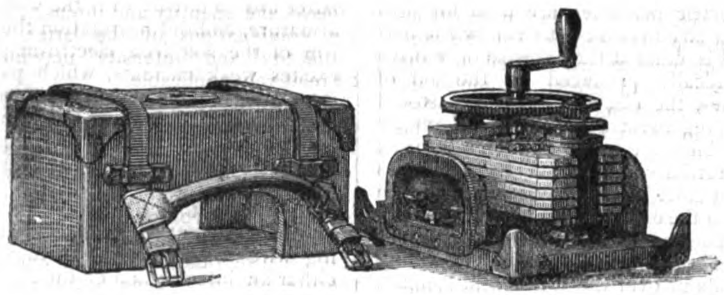


FIG. 1.

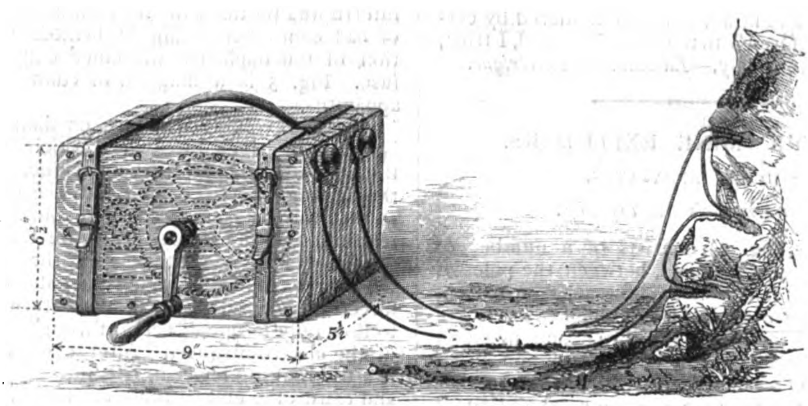


FIG. 2.

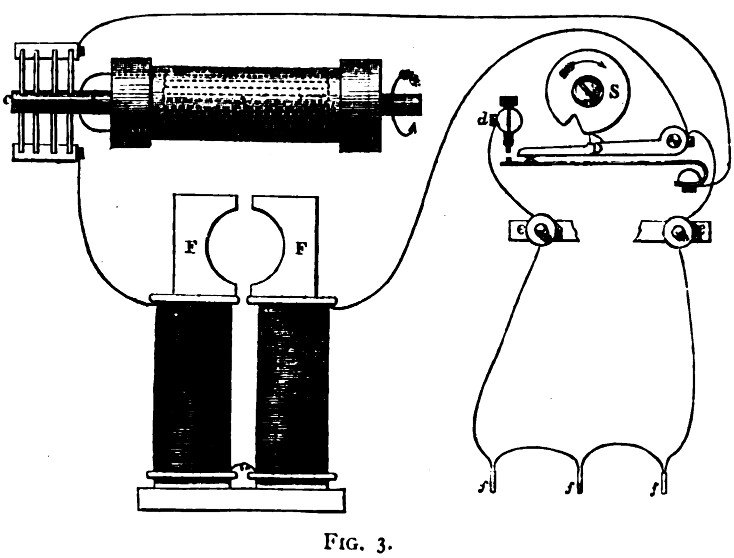


FIG. 3.

about 30 Abel's fuses in single circuit. Dimensions, 12" x 11" x 6".

The large quantity-exploder is similar in construction to the tension-exploder, except that the cam, S, and short circuiting lever, D, are omitted, and the coils of the armature and electro-magnets are wound with wire of large diameter to a total resistance of 8 to 10 units in about 2,000 windings. The electric current is, after a few turns of the handle, sent into the line wire *by pressing down a firing-key at the top of the instrument.* The current then passes continuously into line until it is sufficiently powerful to heat the bridge-wire in the fuse and cause ignition of the explosive priming. Electric currents possessing *great heating power*, but of *small electro-motive force*, are generated by this machine.

Dynamo-electric quantity-exploders are also made with an automatic firing lever, similar to that in the tension-exploders, in place of the above-mentioned firing-key.

The standard of efficiency for these machines is the fusing of a quarter of an inch of iridio-platinum wire of 0·0015 inch diameter, weighing 0·45 grain per yard, through a line resistance of 70 Siemens' units. The weight of the exploder is 71 lbs. Dimensions, 15" x 15" x 7". With short leading-wires this exploder heats 11 inches of iridio-platinum wire of 0·0015 inch diameter, which is equal to about 44 Service Detonators, No. 13.

(*To be continued.*)

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XV.

BATTERIES—(*continued*).

THE description of batteries employed for the various circuits has been governed by the nature of the work they have to do; thus, for Single needle and Bell circuits, where the duration of the contacts is comparatively short, and, consequently, the batteries are not hard worked, the Leclanché is the form employed. For Duplex circuits, under 150 miles in length, and also for Single and Double current circuits generally, the Daniell battery is in use. The small, or, as it is called, the "medium" size Bichromate battery is used on the Wheatstone automatic circuits (to be described hereafter), and also on duplex circuits whose lengths exceed 150 miles. The larger, or "quart" size, are used on "Translator," "Quadruplex," and "News" circuits. (These latter systems will be described in due course.)

For "Local" working it is intended in future that the 5-cell new Daniell battery shall be used. As some of these batteries have been made with 10 cells, in such cases an extra terminal is added in the centre of the trough, so that two 5-cell sets can be formed for the local working.

The expressions "Quantity" and "Intensity," as applied to batteries, are continually used; and, although the latter term is somewhat misleading, yet both have certain meanings, which it may be as well to discuss.

It must first of all be understood that there is a distinction between quantity and intensity *batteries* and quantity and intensity *cells;* the former are combinations of the latter, and the terms "quantity" and "intensity" may not, in both cases, be relatively applicable.

As regards *cells*, if we have a large and a small cell of the same description, both Daniell's or both Bichromates, for instance, then the large cell may be rightly called a "quantity" cell, because it is capable, under certain conditions, of giving out a greater quantity of electricity than the small cell; but it is incorrect to call the latter an "intensity" cell, because this would lead one to suppose that there exists in it some peculiar power which the "quantity" cell does not possess, and this is not so.

The case is the same if we have an equal number of large and small cells of the same description combined in the same way, thus: a 50-cell Daniell battery, with *large* cells, is rightly called a "quantity" battery, because it is capable, under certain conditions, of giving out a large quantity of electricity; but a 50-cell Daniell battery, with small cells, should not be called an "intensity" battery, as under no conditions is it capable of giving a greater current than the "quantity" battery.

We must draw particular attention to the expression used with reference to the peculiar properties of the "quantity" battery, as a very great deal, if not all, the misunderstanding on the subject of quantity and intensity has, we believe, arisen from a deficient explanation. A "quantity" battery is not necessarily a battery which *does* give out a great quantity of electricity, but only one which is *capable* of doing so *under certain conditions*—it is, in fact, a battery which, like a large reservoir of water, is capable of supplying a heavy drain upon it. As a large reservoir is capable of supplying a large number of pipes and keeping them all full of water, even though some of them may be leaky, so a "quantity" battery is capable of supplying a large number of wires with electricity even though some of them are leaky. Now, it must be evident that if a large number of pipes be connected to a small reservoir, that the latter must soon become drained and be incapable of keeping the pipes filled with water, especially if leaks exist; so in the case of a small cell battery, the latter would be incapable of keeping up a good flow of current through many wires, especially leaky ones, and the greater the number of the wires the less would each wire receive, that is to say, the weaker would be the current in each.

Supposing, now, we have a single small pipe to keep supplied with water and we find that a reservoir of a particular size is sufficient to keep the pipe always full, it must be evident that no matter how much larger we make the reservoir we shall get no more water through the tube; so in the case of a small cell battery supplying a wire of high resistance (which corresponds to a small pipe), we shall gain nothing by increasing the size of the cells, since the wire being, as it were, quite full, no more can be put into it. It may be asked what is meant by an "intensity" battery? An "intensity" battery is one which is capable of forcing electricity through an obstacle or a resistance, and the expression "intensity" corresponds exactly to "pressure" in the case of a reservoir supplying pipes with water. As we increase the height of the reservoir

and the level of the water, or the "head" in it, we increase the pressure driving the water through the pipes, and thereby increase the quantity passing through the latter in a given time; so in a battery, by increasing the number of cells, we increase the pressure or potential of the current, and consequently get in a given time a proportionately increased amount flowing through in a given time; the value of this amount flowing through in a given time is the "current strength." Supposing we have a reservoir which is very lofty, but which has a very small area, then if we connect a single small pipe to it we shall have the water driven through it with considerable force; that is to say, the quantity driven through it in a given time will be considerable. If we connect a large number of pipes to the reservoir, it is evident that, in spite of the heavy pressure, so much water will flow out through the pipes that the reservoir will be unable to keep up the supply, consequently the advantage of the heavy pressure will be lost. The case is the same with small cell batteries; if we have a number of small cells, and connect a number of wires to it, then, although we have plenty of pressure or potential, we cannot keep up the supply, and so the current flowing through each wire is comparatively small.

It may be asked, How is it that in certain cases there is no advantage in increasing the number of cells beyond a certain point? The cases in which this occurs are those in which the resistance of the battery is high compared with that of the line—in other words, it is like a pipe supplied by a very small but very lofty reservoir, the latter, in fact, approaching in nature to a pipe. In this case the pipe-like reservoir itself impedes the free flow of the water, and if it be very lofty would impede the flow even more than the pipe itself which it is required to supply.

If we could obtain extra pressure without increasing the height of the reservoir, it is evident that we should get a proportionately increased flow, since we do not in any way increase the resistance to be overcome. In the same way with a battery we can increase the quantity of current flowing in a given time, that is to say, the current strength, by increasing the electro-motive force or potential of the cells; a Bichromate battery, therefore, will give a greater current strength than a Daniell of equal resistance, because its electro-motive force is higher. Regarding, then, the electro-motive force of a battery as pressure independent of height, and the number of cells as pressure dependent upon height, in a reservoir; also regarding the dimensions of each cell as the area of the reservoir; and, lastly, considering the wires as pipes to be supplied with water, a very clear notion may be gained of the difference between so-called "quantity" and "intensity" batteries. As was pointed out, especial care must be taken not to suppose that because a battery is *capable of giving, under certain conditions*, a considerable current, that therefore it *always does* give a considerable current.

We understand that the circular system of pneumatic telegraphs hitherto used in Paris is gradually being superseded by that known as the radial one.

Notes.

The *Marquette Mining Journal* states that the Cleveland Iron Mining Company deserves the credit of first permanently introducing the *lighting of mines by the electric light*. The special form of light used is the Brush, and the journal speaks of its effect as fairly rivalling sunlight, giving full illumination to the working-face, and making the roofs and pillars visible from all directions. The lights are suspended on pulleys from high places in the roof, and the wires are left slack to permit of raising and lowering the lamps without breaking connections.

Pneumatic and Telegraphic Messages.—Mr. Fawcett stated before the House of Commons that the number of pneumatic messages sent in Paris in the course of a month was 40,000, or 480,000 a year. He had further to state that there seemed to be the greatest variety of opinion as to the relative advantages, both financial and otherwise, in the conveying of messages in large cities by means of pneumatic tubes and telegraph wires. He would take steps during the recess to cause an impartial inquiry to be made into the whole subject, with the assistance of one or two competent officials from the Post Office.

Postal Telegraphs.—On the 27th ult., on the motion to go into Committee of Supply, Dr. Cameron called attention to the report of the Select Committee of 1876 on Postal Telegraphs. He showed the great addition that had been made of late years to the carrying capacity of the wires by the invention of new instruments, and pointed out that the number of messages sent had not continued to augment in the same ratio that it did during the first four years of the Post Office administration of the system. This he attributed to the maintenance of the shilling charge. Some further stimulus was wanted. We must bestir ourselves if we did not wish other countries to distance us. In Paris, by means of forty miles of pneumatic tubes, messages were sent from one end of that city to another for half a franc, or by card for threepence. In France a telegraph message could be sent over the wires from one end of a department to another for half a franc, and they had in Belgium an international half-franc system. He believed a sixpenny rate could be adopted in this country without loss to the revenue, and this he sought to prove by a reference to the growing income earned by the Post Office telegraphs. Mr. Fawcett denied that the recommendations of the select committee had been disregarded. He had questioned the heads of departments, and had found that nearly all the proposals of that committee had been carried out so far as time had permitted. He also pointed out that since the date of the committee's report the receipts of the Post Office had greatly increased. During the last four years the receipts had increased from £1,287,000 to £1,471,000, while at the same time the working expenses had only increased from £1,090,000 to £1,117,000. If the proposal of the hon. member for Glasgow was carried out, there would be an immediate diminution in revenue of £112,000 a year. What with the additional capital needed, as well as more labour and a greater number of wires, £167,000 a year would be required to carry out his proposal. Altogether the proposal would reduce the revenue by £283,000 on a capital of ten millions and a half, and this, as might be imagined, resolved itself accordingly into a question for the Chancellor of the Exchequer. If they were going to have a change, the best plan seemed to him

to be in the adoption of a word-rate, with the minimum charge of 6d., and all words above twelve in number to be charged a halfpenny. Dr. Cameron, after remarking that his object had been largely attained by the discussion, withdrew his motion.

The Telephone.—A motion was made on Thursday morning, July 29th, before Vice-Chancellor Malins, to restrain the United Telephone Company from issuing advertisements stating that they were taking proceedings against Mr. Louis J. Crossley, of Halifax, for infringement of their patent for carbon transmitters, pending legal proceedings which Mr. Crossley invited the company to take against him for infringement of the patent. The company are assignees of the Edison patent, and the day after the registration of assignment commenced proceedings against various parties. Mr. Crossley contented that his carbon transmitter, the "compound microphone," was no infringement of the Edison patent assigned to the company. After a short discussion the defendant company undertook not to issue the advertisements complained of, without prejudice to any question of the propriety of the proceedings which had been taken. Mr. Aston, Q.C., Mr. Philbrick, Q.C., and Mr. Macrory, instructed by Messrs. Philbrick and Corpe, 18, Austin Friars, appeared for the plaintiff; and Mr. Glasse, Q.C., and Mr. Cozens Hardy, instructed by Messrs. Waterhouse and Winterbottom, of Lincoln's Inn, appeared for the defendants.

An American has designed an electrical stone-breaker. This apparatus is driven by a dynamo-electric machine, and delivers 1,000 to 2,000 blows per minute.

M. Marcel Deprez has recently invented an electric motor. This machine depends for its action upon the suction-like action of a solenoid on a bar of soft iron, a principle which has been before tried with a continuous solenoid. In the apparatus of Deprez the coil is divided into sections like the separate coils of the ring-armature of the Gramme machine, the current being thus transmitted first to one part of the cylindrical coil and then to another. The commutator which distributes the current successively to the various sections is worked by an excentric on the shaft of the fly-wheel.

Oil Tanks Fired by Lightning.—On the 14th of July a terrible storm with thunder and lightning passed over the neighbourhood of Bradford, Pa., and as usual quite a number of oil tanks were struck and their contents burned. Property to the amount of half a million dollars is reported as having been destroyed. One stroke of lightning fired a 25,000 bl. iron tank full of oil at Custer City, near Bradford, belonging to the United Pipe Lines. Another large tank at Kansas Branch was struck and burned. Tank 367, containing 25,000 bls., on Lewis Run, was also struck and burned. At Coleville, a 250 bl. tank was struck and burned, the flames spreading to other tanks. At Kendall Creek, two wells were struck, and 600 bls. oil consumed. At Sawyer City a well was struck and 250 bls. oil destroyed. At Red Rock two oil rigs and 100 bls. oil were struck and burned. The burning oil from the Custer City tank spread to adjoining tanks and great destruction of property ensued. This is a sad catalogue for one storm. Lightning seems to make a special selection of oil tanks as objects for destruction. Almost every thunderstorm that sweeps over the Pennsylvania oil regions sets oil in a blaze somewhere; but up to the present time no observation seems to have shown exactly how these conflagrations are induced or what the remedy is.

Extensive Electric Light Experiments.—We learn from the *Paper World*, published at Holyoke, Mass., that Mr. H. C. Spaulding, of Boston, who was at first going to put his plans into effect in that city, has gone to Holyoke on account of the cheap power, and has made arrangements with the Water Power Company to put a wheel into their new pit expressly for his use. To make the experiment which he will attempt will require 150 horse-power, enough to run a paper mill. A tower about 175 feet high will be built and surmounted by an immense lantern of such power, says the enthusiastic editor, as to put all former electric lights completely into the shade. Mr. Spaulding will put up this tower and apparatus at his own expense, but he hopes to succeed so well that the city will adopt the system. His idea is that by filling the atmosphere above the city with light from several such electric towers he will get the same effect that we do from the sun and its reflected light, and that the shadows will be no darker than are those made by the sun His idea is to fill the stratum of atmosphere just above the city so completely with light that it will permeate spaces which no direct rays reach, just as the sun's light does immediately after the sun has set. The light which he expects to throw out from one lantern will be equal to 300,000 candles, while the largest electric light yet attempted by any one else has been of but 10,000 candle-power. The estimated cost of the apparatus is 15,000 dols., irrespective of any investment for power, but after the system is once in operation the cost of running it, aside from the power, will be small. The expense of lighting Holyoke at present, public and private, is estimated at 100,000 dols. a year, and for about that amount the seven towers which are proposed could be set up and the lights put into operation.—*Scientific American*.

The President of the French Republic has conferred the honour of a knighthood in the Legion of Honour on M. Serrin, the inventor of the first electric lamp regulator which could be used in lighthouses.

News from Australia in Five Hours.—The telegram conveying the first news of the capture of the Kelly gang of bushrangers was despatched from Sydney at 12.30 p.m. (Sydney time) on the 28th ult., and reached London at 7.33 a.m. (Greenwich time) on the same day, and was published in the second edition of *The Times* on that day. Allowing for the difference of time between Sydney and London—Sydney being 10 hours and 5 minutes in advance of Greenwich time—the actual time occupied in transmission was 5 hours and 8 minutes; thus enabling events at the Antipodes to be published in the London morning papers on the day of their occurrence.

Crompton's Electric Lamp.—Crompton's lamp has been acquired by the British Electric Light Company, and adapted through their agent, Mr. Joshua Horton, to the St. Enoch's Station on a large scale. Originally this magnificent terminus was lighted by 58 pendants, each carrying eight gas jets; but in the autumn of last year it was proposed to substitute six electric lamps, each furnishing a light of 6,000 standard candles, and fed by Gramme machines of the "A" type. Six of these machines were to be employed, and each required some 2½ indicated horse-power. Fortunately this power was obtainable from the laundry engine of the St. Enoch's Station Hotel, which was not always required at night, and had besides a considerable margin of power. The best positions for the lamps were found by experiment. Three lamps are arranged on each side, and suspended from the roof so as to be about 27 ft.

from the side walls, and 35 ft. above the platform. Serrin lamps were tried first and found to be fairly satisfactory, but they were replaced by Crompton's with advantage when that lamp was adopted by the British Electric Light Company. To suit the requirements of the station Crompton's lamp has been inclosed in a lantern fitted with an octagonal glass globe, and likewise a conical mirror reflector, suggested by Sir William Thomson to prevent the rays from passing to the roof and shed, then down on the platform below. The carbons are capable of yielding a steady light for about eight hours without renewal. In order to supply fresh carbons the lamp has to be lowered to the platform. Switch connections have been made so that any or all of the lights can be started or turned off at a moment's notice. This is a decided advantage in a railway station as compared with the slow process of lighting or extinguishing gas by means of a lamp-lighter, who in St. Enoch's generally took 30 minutes to go over all the burners. At St. Enoch's the gas pendants are still kept in their places in case of accident to the electric light. The superior light afforded by electricity as compared with gas renders it especially adapted to railway stations and calculated to expedite the traffic, as well as prevent theft and accidents. The electric light has greatly improved the illumination of St. Enoch's; and in the opinion of Mr. Hogg, the company's engineer, it is very well suited for any station having a high roof. Where the roof is low, the lamps require to be placed low also, and there is too much shadow thrown on the platform from the train carriages. This drawback was made patent by the earlier trials at St. Enoch's.—*Engineering*.

THE German papers publish the following account of an interesting trial which took place in the General Telegraph Office at Berlin, in order to compare the ordinary telephone with some apparatus presented by Mr. Bernstein, C.E., in this city, who is working the Crossley transmitter and telephones. On using an underground line of 30 kilometres (nearly 19 miles) length, whilst Hughes' apparatus were sending their current through the same cable, conversation could be carried on, with the utmost attention, by the microphone, but nothing could be heard with the ordinary telephone on account of the influence of induction. Using another cable of about the same length, whilst Hughes' apparatus were working through a neighbouring cable, a few words could now and then be heard on the ordinary telephone, but by applying the microphone, conversation could be carried on with great ease. At last a long house line was used, and the distinctness and loudness of sound produced by the microphone as compared with the ordinary telephone was very remarkable.

THE number of submarine cables at present in operation in the world is said to be 585, with a cable length of 69,500 nautical miles. A Pacific Ocean link, connecting America with China and Japan, is still lacking to complete the telegraphic girdle about the earth.

ARRANGEMENTS are being made to introduce the telephone into South Australia. It is proposed in the first instance to erect special wires in Adelaide and one to connect with Port Adelaide.

AT the meeting of the Royal Society of Edinburgh, held June 21st, Professor Crystal read a paper on a "Differential Telephone and its application to Electrical Measurements." This instrument corresponds to the differential galvanometer, the use being acoustical instead of visual, and a make and break battery circuit being used. It was stated that to get absolute silence was impossible, as equal resistances and equal co-efficients of self induction of the two coils could not be obtained.

ELECTRIC DISCHARGES THROUGH GASES.—In a recent valuable paper on the thermal and optical behaviour of gases under the influence of electric discharges, Herr E. Wiedemann first studies the thermal phenomena in the case of discharges of the influence-machine, and indicates a different behaviour of the positive and negative electricity. He then describes an experimental attempt at numerical determination of the quantities which produce a change of the band-spectrum of hydrogen into the lime-spectrum. He further investigates the nature of the discharge from the negative electrode in greatly rarefied space. Then he discusses the applicability of other electrical sources, inductoria, large galvanic batteries, and Leyden jars, to spectrum-analytical researches, also the continuous and discontinuous discharges in gases. The paper concludes with theoretical considerations as to the phenomena of discharge in gases and the nature of spectra.—*Nature*.

CANADIAN TELEGRAPHY.—A report by Mr. Sandford Fleming, engineer-in-chief of the Canadian Pacific Railroad, has been issued from the Canadian Government Printing Office at Ottawa. The principal portion of the report deals with the question of the Pacific Railroad telegraph and a submarine extension of the system to Asia. Mr. Fleming dwells at length on the difficulties in telegraphing over American territory which the Canadian Government will experience now that the railroad in British Columbia is being constructed, and constant communications with that province will be maintained. He advocates the immediate construction of a link between Edmonton and Cache Creek, all that remains unconstructed in the line between Winnipeg and British Columbia. He discusses the best means of establishing telegraphic communication between Fort William and Ottawa, and suggests three schemes by which it can be accomplished. He recommends the laying of a submarine cable from the north part of Vancouver's Island to the Aleutian Islands, and thence to Japan *via* the Kurile Islands, connecting with the mainland. Mr. Gisborne, superintendent of the Canadian Government telegraph system, adds that one of the small islands could be purchased from the Japanese Government and used as a landing-place, from which two cables could be laid, one leading to Hong-Kong, in China, and the other to Australia. The cost of completing the Pacific telegraph system and laying these cables is estimated at 4,000,000 dols.

PARIS FIRE TELEGRAPHS. — The city of Paris possesses a very complete organisation of fire alarm telegraphs. The central bureau is situated in the Boulevard du Palais, and is in communication with 11 stations equipped with engines, horses, and men. Besides these stations it communicates also with the Central Water Station, Avenue Victoria, the central station for public assistance, the Prefecture of Police, the central telegraph office, Rue de Grenelle, and the chief omnibus depot in the event of horse relays being required. Each of the 11 stations is in communication with a group of alarm posts, arranged so as to give the best distribution, and comprising 80 signalling points in all. The various circuits have a length of 147 miles; for the greater part of their length their wires, insulated with gutta-percha and inclosed in lead pipes, are laid in the sewers. The fire-engine staff forms a

part of the regular army, constituting a regiment prominent for its activity and intelligence. The central station, whence all directions are issued, is occupied only by officers, though a reserve steam fire-engine is kept there in case of necessity. When one of the stations is advised of a fire from any one of the signalling points, the required engines and men are despatched immediately from that station, and the fire is telegraphed to head-quarters, whence orders to other stations for further assistance are despatched should the case require it. One very important deficiency appears in this otherwise excellent organisation—there are only five steam fire-engines in service, the remainder being hand engines.—*Engineering.*

THE Brooks' system of underground telegraphs (described in T. J., Dec. 1st, 1879), as we have before stated, is to be tried by the Post Office authorities, in the first instance, on a short length of line running by the side of the South-Western Railway, near Vauxhall. On Tuesday, the 10th inst., the cable was drawn into the pipes, it having been previously boiled in paraffin oil, the same oil afterwards being poured into the tubes whilst the cable was being passed through them. Messrs. Graves, Patey, and Eaton, of the Postal Telegraph Department, inspected the operations in the course of the afternoon, as also did Mr. Aylmer, the well-known engineer, who had just arrived from Paris. As there is considerable interest attaching to the results obtained with the Brooks' system, at this, its first trial in England, we hope to be able, ere long, to place them before our readers.

New Patents—1880.

2826. "Telephones." J. IMRAY. (Communicated by C. Herz.) Dated July 9.

2835. "Electric signalling and controlling apparatus for trains or railways." G. W. VON NAWROCKI. (Communicated by T. Balukiewicz.) Dated July 9.

2849. "Signalling apparatus." F. N. GISBORNE. Dated July 10.

2888. "Signalling apparatus for mines." H. J. HADDAN. (Communicated by C. Cummings.) Dated July 13.

2891. "New or improved means or apparatus for detecting or indicating stoppages, breakdowns, or disconnections in telegraphic or pneumatic communications, especially in systems of controlled or synchronised clocks, whether in the line wires or tubes, or in the normal or standard or other instrument connected therewith." J. A. LUND. Dated July 13.

2893. "Apparatus for generating electric currents." W. B. F. ELPHINSTONE and C. W. VINCENT. Dated July 13.

2966. "Production of surfaces for printing, stamping, or embossing." J. J. SACHS. Dated July 19.

2980. "Regulators for electric lamps." A. M. CLARK. (Communicated by J. H. Guest.) Dated July 20.

2989. "An improved thermo-pile." M. S. and P. S. AZAPIS. Dated July 20.

3025. "An improved method of electric lighting, ensuring the independence of the electric burners." P. JENSEN. (Communicated by M. Avenarius.) Dated July 22.

3041. "Improvements in apparatus for producing and directing electric currents and for applying them to the steering of vessels." G. GUMPEL. Dated July 24.

3062. "Automatic fire alarms." R. T. BROWN. (Communicated by F. Bozen.) Dated July 24.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

4653. "Apparatus for the transmission of power by electricity." JOHN HOPKINSON. Dated November 14. 6d. Relates to a method of reversing the direction of rotation of the armature of a dynamo-electric or magneto-electric machines, when the said machines are used for converting an electrical current into mechanical power, and it consists in effecting such reversal by changing the position of the points of contact of the brushes or their equivalents with the commutator or collector of the said machines. In carrying out the invention a pair of copper brushes or equivalent devices to admit the current to and conduct it from the commutator or collector of the armature is employed, these brushes or equivalent devices being arranged in the following manner:—On opposite sides of the axis of the armature are two pins, which are insulated from the frame of the machine and from each other, and are coupled together by means of a link or any other suitable connection, so as to admit of their being turned simultaneously in the same direction; each pin carries a single collecting brush or equivalent device so arranged that when one face of each brush or equivalent device is in contact with the commutator or collector the armature will be caused to revolve in one direction, and that when the opposite face of each brush is in contact with the commutator or collector the armature will be caused to revolve in the opposite direction. By the act, therefore, of turning the pins in one direction or the other through a sufficient angle, so as to bring one face or the other of each brush or equivalent device into contact with the commutator or collector, the motion of the armature in the required direction will be obtained.

4696. "Electro-magnetic engines." A. M. CLARK. (A communication from J. S. Lamar.) Dated November 18. 6d. Relates to improvements in electro-motors, and consists in the novel arrangement of one or more revolving wheels carrying series of electro-magnets, and one or more stationary rim supports carrying series of permanent magnets, and in combination therewith of one or more commutators mounted either on the wheel carrying shaft, or upon an independent shaft connected with the former through suitable gearing. Also, it further consists in the construction and use of a combined brake and reverser, arranged to throw the current in opposite directions to change the rotation of the electro-magnet carrying wheels, after having arrested their motion, and in combination with the wheel or wheels and commutator or commutators of a crown wheel and starting lever. Likewise, it relates to the construction and use of devices for substituting the current from one battery by that from another battery when the current of the former has become too feeble.

4708. "Electric bells." J. WHITE. Dated November 19. 2d. Relates to a new or improved construction or arrangement of parts of electric bell or signalling apparatus to be used on board ship or in hotels, &c. *(Provisional only.)*

4718. "Apparatus for holding the electrodes for use in electric lighting." W. B. GODFREY. Dated November 20. 2d. Relates to carbon holders, and an arrangement of these carbon holders by which, when one pair

of carbons has been burnt down to a given point, another pair shall automatically succeed to the position occupied by the first pair before lighting or when giving out light, and depends upon a wire or cord attached to the carbon at the desired point, such stop being arrested by a fixed point so long as a stop remains intact, but when the carbons burn down to this point, and the stop is either burned or fused by the electric arc, then the apparatus is put in motion and another pair of carbons succeed to those burnt.

4785. "Electric motor." T. J. SMITH. (A communication from Hippolyte Chameroy.) Dated November 24. 2d. It is intended to utilise in a special manner the magnetic action acquired by an electro-magnet, or of a bobbin having an electric current passed through it, to displace by its attraction a rod or bar placed inside it or its neighbourhood or field, and to transform this alternate to and fro movement into a continuous rotary motion; an electric motor is thus obtained. *(Provisional only.)*

4796 "Electric lighting apparatus." TOM ERNEST GATEHOUSE. Dated November 25. 8d. Relates to certain peculiar combinations and arrangements of parts constituting automatic carbon candle holders for electric lighting purposes, applicable to those electric candles wherein two carbon rods are employed, placed parallel to each other without insulating material between them, as well as to what is known as the Jablochkoff candle and others of like character, wherein the two parallel carbons are separated by insulating material which consumes along with them. The object is to enable any number of candles of either of these systems to be introduced into a lamp, and automatically put in circuit, ignited successively, and re-ignited when requisite, which is accomplished by self-acting arrangements of a more simple character, and which are less liable to derangement than those heretofore proposed for the purposes above referred to.

4903. "Telephones." C. E. SCRIBNER. Dated November 29. 8d. (Partly a communication from E. D. Clark, Milo G. Kellogg, and G. B. Scott.) Has for its object, improvements in apparatus and in the arrangement of mechanism and parts to facilitate conversation by telephone between persons at distant places, on the central office system. Each subscriber's wire is caused to terminate in a metal block, and these blocks are arranged upon a board, so that there as many blocks as subscribers. Each block carries a blade similar to the folding blade of a pocket knife, and as in such a knife the blade folds into a groove or recess in the block, the block corresponding to the handle of the knife. A spring also tends to keep the blade closed in its recess. Also it relates to a transmitting telephone, the diaphragm of which in the centre on the under side there is a rounded projection bearing a button of hard carbon; this button rests upon a button of soft carbon, and this upon a thin plate of platinum, forming the face of an adjustable support.

4916. "Compositions for insulating telegraph wires, cables," &c. J. C. MEWBURN. (A communication from J Heins.) Dated December 1. 2d. Two compositions are described, the first to consist of about 50 pounds of asphaltum, 30 of resin, 10 bees-wax, 10 caoutchouc, 10 gallons of linseed oil, 12 pounds of litharge, 15 oxide of manganese, 5 of borax and 5 of lime. The second composition is intended to pour into pipes containing telegraph wires or cables, and consists of 60 gallons of dead oil, 40 pounds of caoutchouc, 1,120 asphaltum, 320 powdered asbestos, and 150 powdered alum.

4948. "Electric signals for railways." J. INGLIS CONKLIN. Dated December 3. 6d. This invention is devised for turning into view a signal to indicate danger during the time that a train is passing along a portion of a railway, and then when the train has reached the next signalling place a new signal is set to indicate danger, and the first signal is turned to indicate safety. An electro-magnet is employed, and an armature with a lever, and a shaft that receives a quarter rotation in one direction by the armature lever acting against a projecting pin on the signal shaft. A latch holds the signal when thus turned, and a spring pusher that is acted upon by the armature, when next moved by the electro-magnet, unlatches the signal shaft, and allows a spring to turn it back to the normal position of safety.

4967. "Pneumatic and electric signalling apparatus." J. CLARK and S. CLARK. Dated December 4. 4d. Consists of a pneumatic tube arrangement with a push at one end and a hinged plate at the other. The hinged plate may be used as an indicator or to complete an electric circuit and then ring a bell, or for both combined. *(Provisional only.)*

4976. See p. 129, TELEGRAPHIC JOURNAL, Vol. 8.

5004. See p. 129, TELEGRAPHIC JOURNAL, Vol. 8.

5009. "Friction telephones or electro-motographs." J. IMRAY. (A communication from J. F. Bailey, of New York.) Dated December 6. 6d. Relates to telephones of the kind known as electro-motographs, founded on the principle applied by Edison, the object of the said invention being to increase the efficiency of instruments of that kind, so as to render them capable of transmitting sounds over considerable distances.

A NEW Marseilles-Algiers Cable, 525 knots in length, has been in course of manufacture by the India-rubber, Gutta-percha, and Telegraph Works Company, Silvertown. The same firm has also been manufacturing some cable for the Dominion of Canada, and have been fitting up their s.s. *Newfield* with telegraph machinery and tanks. These sections of cable are expected to be laid during the month of September or October. The Company's s.s. *International* recently returned from Brazil after an absence of nearly two years in the service of the Western and Brazilian Company. The President of the new American Cable Company has contracted for the manufacture and laying of 500 knots of cable to be laid in two sections between Vera Cruz, Mexico, and the United States.

City Notes.

Old Broad Street, August 11th, 1880.

SUBMARINE CABLES TRUST.—The ninth ordinary annual meeting of the certificate holders in the Submarine Cables Trust was held on July 30th at their offices, 66, Old Broad-street, under the presidency of Mr. Pender, M.P. The chairman, in moving the adoption of the report, said it would be in their recollection that at the last meeting they had a good deal of discussion as to how best they should deal with the company. As they were aware, it was very much the fashion at the time to speak of the decision of the Master of the Rolls as one of the highest authority, and one it was almost hopeless to appeal against. Acting upon the advice, however, of their solicitors, they had got that decision reversed, and the trustees were now again before the certificate holders as a trust company giving full effect to the original principles upon which it was founded. Some people thought the appeal should be carried further, but it was a question for those who wished to contest it to go to the House of Lords, as they were quite satisfied to let the matter rest where it was. To come to the immediate affairs of

the company, it would be seen from the accounts that their revenue for last year amounted to £23,132, plus the sum of £1,696 dividend accrued on Eastern Extension shares, but not paid until after April 15, making a total of £24,828, against £23,562 in the previous year. The expenditure had been £1,420, against £2,000 in the previous year. But included in this last sum was an amount of £689 reserved to cover legal and other expenses in connection with the action which was brought against the trustees, and had just been dismissed by the Court of Appeal. The decree of the Master of the Rolls, that they were an association of more than twenty persons, carrying on a business for the purposes of gain, and consequently ought to be a limited company, had not been upheld by the Court of Appeal. Three other judges, in addition to the late Lord Westbury and Mr. Justice Fry, had now declared that trusts of this character were legal, and he did not think that after the elaborate judgments delivered the other day in the Court of Appeal, that any one would be bold enough to take further action against the trust to test a point about which the trustees had never themselves entertained the slightest doubt. Looking at the balance-sheet and revenue account now before them, it seemed difficult indeed to say that the trustees were carrying on any business. They were simply the recipients of the dividends earned on their investments, and distributors of the amount to the certificate holders, with certain other duties, specially provided for in the trust deed. After meeting their regular coupons, they had an amount in hand of about £4,000 available for the redemption of certificates. With reference to this matter he would mention that during the course of the recent action, the trustees were restricted from dealing with the funds of the trust, except under the direction of the Court, and could not therefore take advantage of the low prices which prevailed a few months ago to purchase any certificates, for which there was always a very limited market. He took the opportunity of announcing that the secretary was ready to receive offers from any certificate holder desirous of selling his bonds. In conclusion, he would only remark that their investments had all materially improved during the past year, and as they were about the steadiest securities going, and there was a distinct revival of trade, he thought they might fairly look forward to the value of their property becoming still further increased. The motion was seconded by the Marquess of Tweeddale, and after a few remarks from Mr. Aston and Mr. Smith, advocating filling up the board of management to its full strength, was unanimously passed. The auditors were then re-elected, and the meeting closed with the usual compliments to the trustees and the chairman.

DIRECT UNITED STATES CABLE COMPANY, LIMITED. —The ordinary general meeting of this company was held on July 29th at the Cannon-street Hotel. Mr. Pender, M.P., the chairman, presided. The report was taken as read. The chairman, in moving its adoption, said the revenue for the half-year after deducting out-payments, amounted to £82,149 0s. 3d., while the working and other expenses for the same period, including interest on debenture and income tax, amounted to £22,863 13s. 9d., leaving a balance of £59,285 as the net profit for the half-year, making, with the £15,677 16s. 7d. brought forward from the previous half-year, a total of £74,963 3s. 1d. The directors now proposed that a dividend of 7s. per share should be distributed, making a dividend of 5 per cent. for the year. This would leave them £22,847 to be carried to the reserve fund, and £21,760 to the next account. The shareholders would remember the accident which occurred during last year to one of their cables. That had caused a good deal of delay and expense. He, however, was glad to say that the expenses of the last half-year had been, with but about one exception, less than in any previous half-year. The French company, against whom this company were now competing, were in operation; but he hoped that before long some arrangement might be come to so as to avoid serious loss to both, but particularly the former company. Should the French company approach this company with fair proposals, they would be most willing to entertain them. The report, having been seconded by Mr. Underdown, was adopted unanimously. The chairman then moved a resolution for the company granting the sum of £1,000 to assist the company's staff in the assurance of their lives. This was agreed to, and a vote of thanks passed to the chairman.

THE GLOBE TELEGRAPH AND TRUST COMPANY, LIMITED.—The seventh ordinary general meeting of the Globe Telegraph and Trust Company, Limited, was held on July 30th at the City Terminus Hotel, Mr. J. Pender, M.P., in the chair. The chairman, in moving the adoption of the report, remarked that the company stood in a better position in every respect than they occupied this time last year. Their securities stood about 19 per cent. higher than their aggregate market value, and the directors were able to pay rather a higher dividend. They now paid a dividend of 4½ per cent. to the ordinary shareholders as against 4¼ per cent. last year. This was equal to a dividend of 4½ per cent. on the ordinary shares since the formation of the company. He hoped that this satisfactory state of things might continue. If the competition between the Atlantic and French companies could be put an end to, no doubt the existing satisfactory state of affairs would continue, because the general progress of telegraphy was pretty certain to go on, and greater facilities would be afforded for the carrying on of their operations. When the time came for dealing with the question of competition the shareholders might rest satisfied they had a board composed of men of peace, but that they were at the same time persons in whose hands the interests of the company rested safely. In the balance-sheet were given particulars as to the financial position of the company up to the date of the drawing up of that document. The shareholders had, no doubt, looked over those figures. Comparing them with those of previous years, he thought the shareholders would acknowledge that they had continued to go on satisfactorily enough. A good indication of the confidence reposed in the company was the fact that the number of shareholders since 1873, when the company was started, had increased from 1,777 to 5,461. In July, 1874, they stood at 2,744; in July, 1875, at 3,164; in July, 1876, at 3,651; in July, 1877, at 4,024; in July, 1878, at 4,400; in July, 1879, at 4,880; and in July this year at 5,461. This increase, he considered, had been marked. In fact, during the past half-year there had been an increase of 500. The value of the shares had also shown a considerable increase, being something like 14¾ higher than what they were last year, and the market price of their securities was 9¾ per cent. over the market value. So far as he was able to judge, he was satisfied that this satisfactory state of affairs would continue. Sir. D. Gooch, M.P., seconded the motion for the adoption of the report, and it was agreed to unanimously. On the motion for the re-election of the retiring directors, Mr. Newton stated that Mr. Pender was already a director of 14 public companies, and was chairman of nine of them. He suggested that it was not well for a gentleman to be involved in so many undertakings. Mr. Pender intimated that he left himself entirely in the hands of the shareholders, remarking that he was perfectly independent of the

position he occupied in the company. He had, however, made telegraphs a hobby; he had been so far successfully riding that hobby, not only for the benefit of himself, but for the benefit of the whole world—(applause)—and he had no desire to sever himself from that service for the present. If, however, the shareholders wished, he would at once retire from the board. (Cries of "No.") Several shareholders protested against the suggestion thrown out by Mr. Newton, and testified to the great services which Mr. Pender had rendered not only to the company but to telegraphy generally. Mr. Pender and Sir James Anderson were then unanimously re-elected directors. A vote of thanks to the chairman and directors concluded the proceedings.

SUBMARINE TELEGRAPH COMPANY.—The half-yearly general meeting of the proprietors of the Submarine Telegraph Company between Europe and the Continent of Europe, was held on August 3rd at the City Terminus Hotel, under the presidency of Sir James Carmichael, the chairman. The report of the directors stated that the receipts for the six months ending the 30th June, 1880, amounted to £63,866, being an increase of £2,869 over the sum received in the corresponding period of 1879; but this increase was obtained in the course of the first three months of the half-year, when the former tariffs were in operation. The result of the business during the past half-year enabled them to make the usual addition to the reserve fund, and to recommend the payment of a dividend at the rate of 19 per cent. per annum. The cable between Déolen (near Brest) and Penzance, which was alluded to in the last report, had been successfully laid down; and the agreement between the Paris and New York Telegraph Company and the Submarine Telegraph Companies came into force on the 1st June last, when the line was opened for the transmission of messages. The chairman, in moving the adoption of the report, stated that that was the first time they had ever paid 19 per cent., and he hoped it would not be the last. He thought he might congratulate them on the dividend, as that dividend had been earned at a very moderate increase of the working expenses. With regard to the progress of their business, in the quarter ending March 31st, 1879, they transmitted over their wires 365,580 messages, and in the same quarter this year they carried 499,035. Then came into operation the new word tariff between France, England, and the Continent generally. In the second quarter of 1879 (from March to June) they carried 417,372 messages; while in the same quarter of this year they carried no fewer than 557,211 messages. In one day in June last they transmitted 8,367 messages between their offices and the Continent. These figures spoke for themselves, and showed a very great increase in their business. At the same time they must be prepared at first, as he had told them, for a diminution in the receipts from the operation of the word-rate, as the tariff was thus very greatly reduced, which was a great boon to the public. When the old tariff prevailed they received for country messages 6f., or 5s., and between London and Paris 4f., or 3s. 4d., but since the word-rate system had been in operation, they had received 25 centimes or 2½d. per word for all parts, the differential rates having been all done away with. They must, therefore, look to a very great increase in their business to make up for the reduction in the tariffs, and the figures he had given, he thought, showed that they might fairly look for such an increase. For the last two months there had been an increase in the number of messages, and the diminution in the receipts was about £600 at the outside. Looking at the large reduction in the rates, he thought that was most encouraging as regarded the future, particularly if trade was more prosperous and there should be a good harvest. Their cables were all in good order at the present moment, and there had been fewer accidents than usual in the last six months. That, however, might not continue, and in the next six months they might have more, though, of course, they had taken every means to provide against accidents. They had a steamer always ready to go to sea and pick up their cables, which were brought in and immediately repaired and relaid; and they kept all their cables in the best possible condition. He might mention that the steamer was in most excellent order, and had again been overhauled under the supervision of the Board of Trade. Mr. Ford seconded the motion, and asked whether, in face of the increased traffic referred to by the chairman, the company had sufficient cable power. The chairman, in reply, said that up to the present time he thought their cables were quite sufficient, but the time might, and he hoped would, come when they would be insufficient. Mr. C. Smith asked if it was in contemplation to increase the reserve fund of the company? He thought the reserve fund and the prosperity of the company were very inadequate to each other. It was very satisfactory to be building up their dividends as they were doing, but while their dividend was 1 per cent. off 20 per cent., the sum carried forward was very small. He therefore suggested—and afterwards moved it as a resolution—that if they paid 20 per cent. dividend, they should carry over all the other profits to the reserve fund. The prosperity of the company did not stop at a 19 per cent. dividend, and he thought it was very material to the welfare of the company that they should have a strong reserve fund. He made these remarks not in any antagonistic spirit, but having regard to the best interests of the company. Mr. Ford briefly seconded the motion. Mr. Raines thought it was rather premature to discuss the matter until they had the 20 per cent. Sir Julian Goldsmid, Bart., observed that before he was a member of the board he always supported what was then the practice of the company, namely, to put by 10 per cent. every year to the reserve fund. A short time after that a large number of shareholders from Liverpool and Manchester were of opinion that as far as possible everything should be divided, forgetting that the reserve fund was an essential thing for the prosperity of the company. They wanted to reduce the sum put by to the reserve fund to 5 per cent., and being in a majority, they carried their views. He was glad that they did not now seem to possess the same influence. It was most important that the reserve fund should be a large one. The chairman endorsed the remarks of Sir J. Goldsmid, and said that the opinion of the board had always been in favour of the reserve fund being a large one. He, however, thought that the shareholders should at once instruct the board how they should proceed, and not wait until the dividend was 20 per cent. Other shareholders supported the principle of the reserve fund being increased, and ultimately, after the adoption of the report, the following resolution was unanimously passed:—"That for the future 10 per cent. of the gross receipts, in lieu of the present proportion of 5 per cent. be added to the reserve fund half-yearly." The dividend at the rate of 19 per cent. per annum was declared, and the Hon. Ashley Ponsonby, Mr. C. Sanderson, the retiring directors, were re-elected, as were also the retiring auditors, Messrs. G. C. Capper, W. R. Cole, and Sir T. Dakin. A vote of thanks to the chairman and directors was passed, and the chairman, in reply, said he hoped their next meeting would pass off as well as the present. He congratulated them on

the wisdom they had displayed in passing the resolution to increase the reserve fund. The meeting then separated.

ANGLO-AMERICAN TELEGRAPH COMPANY. — The ordinary general meeting of the Anglo-American Telegraph Company was held on August 6th at the City Terminus Hotel, under the presidency of Viscount Monck. The report of the directors stated that the total receipts for the half-year, from the 1st January, 1880, including a balance of £5,160 brought over from the last account, amounted to £272,231. The traffic receipts showed a decrease of £19,970 as compared with the corresponding period last year. The total expenses of the half-year, including income-tax and repair of cables, &c., amounted to £56,044. The directors, under the powers conferred upon them by the articles of association, had, before declaring the net profits, set apart the sum of £75,000 to the renewal fund, leaving an available balance of £141,187. One quarterly interim dividend of 2 per cent. on the preferred stock, and of 1 per cent. on the ordinary stock, free of income-tax, was paid on the 1st May, 1880, absorbing £70,000, and a second quarterly interim divided at the same rates, free of income-tax, was paid on the 3rd inst., leaving a balance of £1,187 to be carried forward to the next account. The cable laid by the company in the year 1873 was broken off the coast of Ireland on the 2nd of April, 1880, and was repaired on the 15th of the same month by the Telegraph Construction and Maintenance Company's steamship *Scotia*. The rapidity and efficiency with which the repair was effected reflects great credit upon that company, and the officers, scientific staff, and crew of the vessel. With the foregoing exception, the company's cables, both in deep and shoal water, had continued in good working order and condition during the half-year. A contract was entered into in the month of April last with the Telegraph Construction and Maintenance Company for the manufacture and laying of 1,506 knots of dee p-sea cable, and 310 knots of shoal-water cable, the former to be laid between Valentia, Ireland, and Heart's Content, Newfoundland, and the latter between Placentia, Newfoundland, and a point near North Sydney, Cape Breton, touching at St. Pierre, Miquelon. The contract price for the above work was under £500,000, and the whole outlay would be paid out of the renewal fund. The above-mentioned lengths of cable, with the addition of 200 miles of deep-sea cable in stock, would be connected to the shore ends of 1866 cable on both sides of the Atlantic, and would form a new line of communication from end to end of the company's system. The chairman, in moving the adoption of the report, said that since their last meeting great changes had occurred in the political aspect of the country, as to which opinions might differ; but he thought there could be but one feeling of general satisfaction and thankfulness at the changes which had occurred during the same period, to some extent, in the commercial and agricultural condition of the country. He did not think any one could say with truth that the country had emerged entirely from the period of commercial depression which had so long oppressed us, but on all sides he thought they could see evidences of the beginning of a new period, which he hoped would be a long one, of commercial prosperity. That could not fail to affect the company in a very material degree, because the result of events in the past few years had established beyond question the fact that telegraphy had now become as necessary to trade and commerce as the money or the credit by which trade and commerce were conducted. He reminded them that at their last meeting they had just commenced the preparation for a competition with the new French telegraph company. He could not then tell them what the result of that would be on their traffic in the current half-year, but he ventured to state that they need not be unhappy, and he thought that their report for the half-year proved that his prophecy on that occasion was well founded. He thought they had come well out of the half-year's transactions. With regard to the competition in which they were now engaged, he held, commercially as well as politically, that unless war was a necessity it was a great crime; but, unfortunately, during the last 10 years, notwithstanding the strength of his convictions on the subject, they had scarcely ever been in a state of peace. They had, however, throughout acted purely on the defensive. With regard to the present contest, it was carried on purely for the sake of providing a permanent and advantageous peace, and the directors were perfectly prepared, whenever terms which they considered conducive to the interests of the company were afforded to them, to conclude such a peace, always assuming that they had ground for supposing that it would be permanent and advantageous. They had never before had for such a long period a low tariff operation; but there was no doubt that those who had the management of the company's affairs would derive a great deal of useful information from it. He then referred to the laying of the new cable, and said in a few days they hoped to receive information of the successful accomplishment of that important work. The cable was of the most approved type, with all the new inventions, and would be paid for out of the company's reserve. He referred to the effect of the reduction of the tariff from 3s. to 6d. a word in increasing the work and consequently the expenditure, while at the same time it had diminished their receipts. After expressing the deep regret of the board at the death of Captain A. T. Hamilton, he moved the resolution. The Hon. R. Grimston seconded the motion, and, in reply to questions, the chairman said he did not think it would be judicious to say the amount of work they had been carrying. By means of the duplex system they were enabled with the same cables to carry about twice the amount of traffic they could carry a few years ago. The motion was adopted unanimously, and the usual votes of thanks terminated the proceedings.

INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.—The half-yearly general meeting of the above company took place on August 5th, at the Cannon-street Hotel, under the presidency of Mr. G. Henderson. The report stated that, after deducting the usual depreciation on buildings and machinery, the net profit made by the company in the six months ending 30th June was £20,150. Of this sum the directors proposed to distribute an interim dividend for the half-year of 10s. per share, free of income-tax, being at the rate of 10 per cent. per annum, payable on the 6th inst. This would absorb £15,600, and leave £4,550 to be added to the £4,278 brought forward on 31st December last, making the balance to be carried forward £8,828. The chairman said the meeting had been called to obtain their sanction to the payment of an interim dividend, which had been fairly earned. He was glad to say that the business of the company was proceeding in as satisfactory a manner as could be expected, considering the continued high price of india-rubber. He moved the payment of the dividend recommended, payable on and after the 6th inst. Mr. S. W. Silver seconded the motion, and it was carried unanimously without discussion. Mr. D. H. Small moved, and Mr. Keys seconded, a vote of thanks to the chairman and directors, the former gentleman observing that the profits must have been very good. The motion was

carried unanimously, and the chairman having replied, the meeting separated.

THE WEST COAST OF AMERICA TELEGRAPH COMPANY, LIMITED.—The report states that the accounts of the company for the year ending December 31st, 1879, show the gross revenue to be £26,530 9s., and the expenditure £32,293 9s. 11d., including £11,768 for payment of debenture interest, leaving a balance of £5,763 0s. 11d. to the debit of revenue account. As the shareholders are already aware, the falling off in the traffic receipts is due to the war between Chili and Peru, the following sections having been cut by the Chilian war vessels, viz.:—Antofagasta-Iquique; Iquique-Arica; Arica-Mollendo; Mollendo-Chorrillos. The company's steamer has been prevented from obtaining employment in water carrying owing to the war. Her earnings during the past year were as follows: salvage, £1,636 6s. 7d., freight, £1,030 14s. 5d., towage, £52 17s. 3d., total, £2,719 18s. 3d. Every kind of cable work required has been successfully undertaken by the steamer, and her adaptability for salvage purposes fully proved. The fourth ordinary general meeting was held on August 6th, at the Terminus Hotel, under the presidency of Mr. Neil Bannatyne. The chairman, in moving the adoption of the report, said they were much in the same position as they were when they last met. The war was not yet at an end, and although, so far as one could form an opinion, it was probably much nearer its end than it was six months ago, until it was really ended they could not look for any great improvement in their traffic receipts. With regard to the position of their cables at the present time, the Iquique-Antofagasta section was repaired by the 1st of December last, re-establishing communication between Iquique and Valparaiso, but the sections north of Iquique were still interrupted—Iquique-Arica, Arica-Mollendo, and Mollendo-Chorrillos. They had made a claim on the Chilian Government for the amount of traffic lost in consequence of these interruptions, and also for the expense that must be incurred by the company in repairing them. They had not yet received any definite reply to their claims, but they were urging their correspondent to use all means to get an early settlement. Mr. A. R. Johnston seconded the motion, and in reply to Dr. Beattie, the chairman said that Mr. Kendal was elected a director by a majority at their last general meeting, and they had taken counsel's opinion on the matter. The election did not require confirmation by the shareholders at this meeting. Dr. Beattie thought there was some inconsistency in the articles of association on the matter, and intimated that at the next meeting he should move an alteration in them. The motion was then carried unanimously. Replying to a vote of thanks, the chairman spoke of the difficulty in which they were placed by their cables being cut, owing to which they did not know from one fortnight to another what their position was. The meeting then separated.

THE following circular has been issued to the shareholders of the Western and Brazilian Telegraph Company, Limited:—

"19, Great Winchester Street, E.C.,
"London, 29th July, 1880.

"Your directors have recently ascertained the particulars of a litigation pending at the suit of the Liquidators of Hooper's Telegraph Works, Limited, against the directors of that company, seeking to recover an amount said to have been improperly added to the contracts for the manufacture of the cables of the Great Western Telegraph Company (of which this company is a reconstitution), the Western and Brazilian and the Central American Telegraph Companies.

"Until definite information had been obtained by the board it was undesirable that any communication affecting the former directors of this company and others should be made to the shareholders, but, so soon as the facts were sufficiently ascertained, the directors deemed it their duty to submit the case to counsel.

"The matter was referred to the solicitor of the company for advice some time before the issue of the recent circulars on this subject to the shareholders, but time was necessarily occupied in obtaining a full statement of facts, which Hooper's company declined to facilitate.

"Mr. Benjamin, Q.C., and Mr. Rigby both advised that the amounts so sought to be recovered, or so much as may be decided to be ultimately recoverable, belong to this company, and that it is the duty of the board to undertake proceedings on behalf of the company for their restitution.

"Acting upon this opinion proceedings have been commenced by your board against the parties indicated in the opinion, and such proceedings will be prosecuted with vigour, but while the matter is *sub judice* it would be improper on the part of the board further to discuss the facts of the case.

"Meanwhile the shareholders may rest assured that nothing will be left undone to protect their interests.

"Sir E. W. Watkin, Bart., M.P., has resigned his seat at the board, and Mr. Henry Cooke has been elected chairman by the board.

"By order,
"R. M. CUNNINGHAM, *Secretary.*

THE Direct United States Cable Company notify that the scrip certificates of their 6 per cent. debenture loan may now be exchanged for debentures at the company's offices, 52, Old Broad Street, London, E.C.

The following are the final quotations of telegraphs.—Anglo-American Limited, 64-64½; Ditto, Preferred, 95¾-96½; Ditto, Deferred, 36¼-36¾; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9-9¼; Cuba, Limited, 9¼-9¾; Cuba, Limited, 10 per cent. Preference, 16-17; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11¼-11½; Direct United States Cable, Limited, 1877, 12⅜-12⅝; Scrip of Debentures, 103-105; Eastern, Limited, 9¾-10; Eastern 6 per cent. Preference, 12½-12¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 103-106; Eastern 5 per cent. Debentures, repayable August, 1887, 102-105; Eastern, 5 per cent., repayable Aug., 1899, 103-106; Eastern Extension, Australasian and China, Limited, 9¾-10; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 103-105; Ditto, registered, repayable 1900, 103-106; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 102-104; Ditto, ditto, to bearer, 101-103; German Union Telegraph and Trust, 9¼-9¾; Globe Telegraph and Trust, Limited, 6⅜-6⅞; Globe, 6 per cent. Preference, 12⅜-12⅞; Great Northern, 9⅛-9⅜; Indo-European, Limited, 24¾-25½; London Platino-Brazilian, Limited, 5-5⅜; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 9⅜-10⅛; Submarine, 245-255; Submarine Scrip, 2¼-2½; West Coast of America, Limited, 2¼-2⅜; West India and Panama, Limited, 1⅛-1¾; Ditto, 6 per cent. First Preference, 7¼-7⅝; Ditto, ditto, Second Preference, 6½-7; Western and Brazilian, Limited, 7-7¼; Ditto, 6 per cent. Debentures "A," ——; Ditto, ditto, ditto, "B," 95-98; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 33¾-34¼; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3⅜-3⅞; India Rubber Company 15-15½; Ditto 6 per cent. Debenture, 105-107.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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THE BRITISH ASSOCIATION MEETING.

THE address of Professor A. C. Ramsay, the President of the British Association, although a masterpiece of its kind, was hardly one to excite general attention, the scope of the subject (geology) being necessarily narrow. The address of Professor W. G. Adams, the President of the Mathematical and Physical Section, was of a different nature, and is one likely to prove of considerable interest to scientific men generally. Departing from our usual course, therefore, we do not propose to give Professor Ramsay's address, but to give that of Professor Adams' at length, as follows :—

It has been said by a former President of this Section of the British Association, that the President of a Section ought to occupy your time, not by speaking of himself or his own feelings, but by a review, "more or less extensive of those branches of science which form the proper business of this section." He may give a rapid sketch of the progress of mathematical science during the year, or he may select some one special subject, or he may take a middle course, neither so extensive as the first nor so limited as the second.

There are many branches of science which have always been regarded as properly belonging to our Section, and the range is already wide; but it is becoming more and more true every day that the sciences which are dealt with in other sections of the Association are becoming branches of physics, *i.e.*, are yielding results of vast importance when the methods and established principles of physics are applied to them. I wish to direct your attention to investigations which are being made in that fertile region for discovery, the "border land" between chemistry and physics, where we have to deal with the constitution of bodies, and where we are tempted to speculate on the existence of matter and on the nature of the forces by which the different parts of it are bound together, or become so transformed that all resemblance to their former state is lost. It is not long since the theory of exchanges became thoroughly recognised in the domain of radiant heat, and yet it is already recognised and accepted in the theory of chemical combination. Just as the molecules of a body which remains at a constant temperature are continuously giving up their heat motion to surrounding molecules, and getting back from them as much motion of the same kind in return, so in a chemical compound which does not appear to be undergoing change, the combining molecules are continuously giving up their chemical or combining motions, to surrounding molecules and receiving again from them as much combining motion in return. We may say that each molecule is, as far as we can see, constantly dancing in perfect time with a partner, and yet is continuously changing partners. When such an idea of chemical motion is accepted, we can the more easily understand that chemical combination means the alteration of chemical motion which arises from the introduction of a new element into the space already occupied, and the consequent change in the motion of the new compound as revealed to us in the spectroscope. We can also the more readily understand that in changing from the old to the new form or rate of motion, there may be a development of energy in the shape of heat motion which may escape or become dissipated wherever a means of escape presents itself. We know from the experiments of Joule and of M. Favre that as much heat is absorbed during the decomposition of an electrolyte as is given out again by the combination of the substances composing it.

We are making rapid strides towards the exact determination of those relations between the various modes of motion or forms of energy which were so ably shadowed forth, and their existence established long ago, by Sir William Grove in his Correlation of the Physical Forces, where, in stating the conclusion of his comparison of the mutual interchange of physical forces, he distinctly lays down the principles of energy in this statement, "Each force is definitely and equivalently convertible into any other; and where experiment does not give the full equivalent, it is because the initial force has been dissipated, not lost, by conversion into other unrecognised forces. The equivalent is the limit never practically reached."

The laws of Faraday, that (1) when a compound is electrolysed the mass of the substance decomposed is proportional to the quantity of electricity which has produced the change, and that (2) the same current decomposes equivalent quantities of different substances —*i.e.*, quantities of their elements in the ratio of their combining numbers, have given rise to several determinations of the relation between chemical affinity and electromotive force. In a paper lately communicated to the Physical Society, Dr. Wright has discussed these several determinations, and has given an account of a new determination by himself. The data at present extant show that when 1 gramme of hydrogen unites with 7·98 grammes of oxygen there are about 34,100 units of heat given out, making the latent heat of dissociation of *1 gramme of water equal to 3,797 units*. The results obtained are compared with the heat given out by the combustion of hydrogen and oxygen, and the value of the mechanical equivalent of heat is deduced from these determinations.

The value of this mechanical equivalent obtained by Dr. Wright, which depends on the value of Clark's standard cell, and, therefore, depends upon the value of the ohm, agrees fairly well with Joule's determination from the heat produced by an electric current in a wire, but is greater than Joule's value as obtained from his water-friction experiments. This may be accounted for by supposing an error in the value of the ohm or B.A. unit, making it too large by 1·5 or 2 per cent. Kohlrausch has also made comparisons of copies of the B.A. unit with standard coils, and comes to the conclusion that the B.A. unit is 1·96 per cent. too large. On the other hand, Professor Rowland, in America, has made a new determination, and finds that according to his calculations the B.A. unit is nearly 1 per cent. too small. These differences in the values obtained by different methods clearly point to the necessity for one or more new determinations of the unit, and I would venture to suggest that a determination should be made under the authority of this Association, by a committee appointed to carry out the work. And it is not sufficient that this determination should be made once for all, for there is reason to think that the resistance of standard coils alters with time, even when the material has been carefully selected. It has been found that coils of platinum silver which were correct copies of the standard ohm

have become so altered, and have their temperature coefficients so changed, that there are doubts as to the constancy of the standards themselves. Pieces of platinum-silver alloy cut from the same rod have been found to have different temperature coefficients. The value ·031 for 1° C. is given by Matthiessen for this alloy, yet two pieces of wire drawn from the same rod have given, one ·021 per cent. and the other ·04 per cent. for 1° C.

Possibly this irregularity in the platinum-silver alloys may be due to something analogous to the segregation which Mr. Roberts has found to take place in copper-silver alloys in their molten state, and which Matthiessen in 1860 regarded as mechanical mixtures of allotropic modifications of the alloy.

A recommendation has been made that apparatus for determining the ohm should be set up in London, and that periodically determinations be made to test the electrical constancy of the metals and alloys used in making coils. A committee should be authorised to test coils and issue certificates of their accuracy, just as is done by the Kew Committee with regard to meteorological instruments. The direct relation between heat and chemical work has been established, and the principles of conservation of energy been shown to be true in chemistry by the experiments of Berthelot and of Thomsen, so that we may say that when a system of bodies passes through any succession of chemical changes, the heat evolved or absorbed when no external mechanical effect is produced depends solely upon the initial and final states of the system of bodies, whatever be the nature or the order of the transformations. The extension of this principle to the interaction of the molecules and atoms of bodies on one another is of vast importance in relation to our knowledge of the constitution of matter, for it enables us to state that each chemical compound has a distinct level or potential which may be called its own, and that when a compound gives up one of its elements to another body, the heat evolved in the reaction is the difference between the heat of formation of the first compound and that of the resulting product.

We have become accustomed to regard matter as made up of molecules, and those molecules to be made up of atoms separated from one another by distances which are great in comparison with the size of the atom, which we may regard as the smallest piece of matter that we can have any conception of. Each atom is surrounded by an envelope of ether which accompanies it in all its movements. The density of the ether increases rapidly as an atom is approached, and it would seem that there must be some force of attraction between the atom and its ether envelope. All the atoms have motions of translations in all possible directions, and according to the theories of Maxwell and Boltymann, and the experiments of Kundt, Warburg, and others on the specific heat of vapours, in one-atom molecules in the gaseous state there is no motion of rottaion. According to the theory of Pictet, the liquid state being the first condensation from the gaseous state must consist of at least two gaseous atoms combined. These two atoms are bound to one another through their ether envelopes. Then the solid state results from the condensation of a liquid, and so a solid molecule must consist of at least two liquid molecules, *i.e.*, at least four gaseous molecules, each surrounded by an atmosphere of ether. M. Pictet imagines these atoms to be centres of attraction; hence in the solid with four such centres the least displacement brings into action couples tending to prevent the molecule from hoisting as soon as external forces act upon it. All the molecules constituting a solid will be rigidly set with regard to one another, for the least displacement sets in action a couple or an opposing force in the molecules on one another.

Let us now follow the sketch which M. Pictet has given of changes which we may consider it to undergo when we expend energy upon it. Suppose a solid body is at absolute zero of temperature, which may be regarded as the state in which the molecules of a body are in stable equilibrium and at rest, the application of heat gives a vibratory motion to the molecules of the solid, which increases with the temperature, the mean amplitude of vibration being a measure of the temperature. We may regard the sum of all the molecular forces as the specific heat of the body, and the product of the sum of all the molecular forces by the mean amplitude of the oscillations; *i.e.*, the product of the specific heat and the temperature will be the quantity of heat or the energy of motion of the body. As more and more heat is applied, the amplitude of vibration of the molecules increases until it is too great for the molecular forces, or forces of cohesion, and the melting-point of the solid is reached. Besides their vibratory motion, the molecules are now capable of motions of translation from place to place among one another. To reduce the solid to the liquid state, *i.e.*, to make the amplitude of vibration of the molecules sufficient to prevent them from coming within the sphere of the forces of cohesion, requires a quantity of heat which does not appear as temperature or molecular motion, and hence it is termed the latent heat of fusion. The temperature remains constant until the melting is complete, the heat being spent in bursting the bonds of the solid. Then a further application of heat increases the amplitude of vibration, or raises the temperature of the liquid at a rate depending on its specific heat until the succession of blows of the molecules overcomes the external pressure and the boiling-point is reached. An additional quantity of heat is applied which is spent in changing the body to a gas, *i.e.*, to a state of higher potential, in which the motion of translation of the molecules is enormously increased. When this state is attained, the temperature of the gas again begins to increase, as heat is applied, until we arrive at a certain point, when dissociation begins, and the molecules of the separate substances of which the body is composed have so large an amplitude of vibration that the bond which unites them can no longer bring them again into their former positions. The potential of the substances is again raised by a quantity which is proportional to its chemical affinity. Again, we may increase the amplitude of vibration, *i.e.*, the temperature of the molecules, and imagine the possibility of getting higher and higher degrees of dissociation.

If temperature means the amplitude of vibration of the molecules, then only those bodies which have their temperatures increased by the same amount when equal amounts of heat are applied to them can possibly combine with one another; and so the fact that the increase of temperature bears a fixed ratio to the increase of heat may be the cause in virtue of which bodies can combine with one another. Were other bodies to begin to combine together at any definite temperature, they would immediately be torn to pieces again when the temperature is even slightly raised, because the amplitudes of vibration of their molecules no longer remain the same. This idea of temperature is supported by the fact that a combining molecule of each substance requires the same amount of heat to raise its temperature by the same number of degrees, the atomic weights being proportional to the masses of the combining molecules. The celebrated discovery of Faraday, that in a voltameter the work done by an electric current always decomposes equivalent quantities of different substances, combined with the fact that

in the whole range of the physical forces work done is equivalent to the application heat, is quite in accordance with the view that no molecule can combine with another which has not its amplitude of vibration altered by the same amount when equal quantities of heat are applied to both. As soon as we get any divergence from this state of equal motions for equal increments of heat, then we should expect that a further dissociation of molecules would take place, and that only those which are capable of moving together can remain still associated. Just as in the change of state of a body from the solid to the liquid, or from the liquid to the gas, a great amount of heat is spent in increasing the motion of translation of the molecules without altering the temperature, so a great amount of heat is spent in producing dissociation without increasing the temperature of the dissociated substances, since the principle of conservation of energy has been shown by M. Berthelot to hold for the dissociation of bodies. We may conveniently make use of the term latent heat of dissociation, for the heat required to dissociate a unit of mass of a substance.

We may thus sum up the laws of physical and chemical changes:—

1. All the physical phenomena of change of state consist in the subdivision of the body into molecules or particles identical with one another.

2. The reconstitution of a body into a liquid or a solid being independent of the relative position of the molecules, only depends on the pressure and temperature.

3. Dissociation separates bodies into their elements, which are of different kinds, and the temperature remains constant during dissociation.

4. The reunion of dissociated bodies depends on the relative position of the elements, and so depends on the grouping of the molecules. The atomic weight being the mass of a molecule as compared with hydrogen, the specific volume, *i.e.*, the atomic weight divided by the density, is the volume or *mean free path* of a molecule.

Building up his theory of heat on these principles, M. Pictet arrives at a definite relation between the atomic weight of a body, its density, its melting-point, and its coefficient of expansion, which may be stated thus—

The volume of a solid body will be increased as the temperature rises by an amount which is proportional to the number of molecules in it, and inversely as its specific heat. At a certain temperature peculiar to each body, the amplitude of the heat oscillation is sufficient to melt the solid, and we are led to admit that for all bodies the intermolecular distance corresponding to fusion ought to be the same. The higher the point of fusion of a body, the shorter, on this theory, must be its heat vibrations. The product of the length of *swing* (the heat oscillations) by the temperature of fusion ought to be a constant number for all solid bodies.

A comparison of the values of the various quantities involved in these statements shows a very satisfactory agreement between theory and experiment, from which it appears that for many different substances the product of the length of swing by the temperature of fusion lies between 3·3 and 3·7 for most substances. Not many values of the latent heat of dissociation have been made. In order to determine it, say, for the separation of oxygen and hydrogen, we should have to determine the amount of work required to produce a spark in a mixture of oxygen and hydrogen, and to measure the exact amount of water or vapour of water combined by the spark as well as the range of temperature through which it had passed after its formation.

Our usual mode of producing heat is by the combination of the molecules of different substances, and we are limited in the production of high temperatures, and in the quantity of available heat necessary to dissociate any considerable quantity of matter. If we heat vapours or gases, we may raise their temperatures up to a point corresponding to the dissociation of their molecules, and we are limited in our chemical actions to the temperatures which can be obtained by combining together the most refractory substances, as we are dependent on this combination for our supply of heat.

The combination of carbon and hydrogen with oxygen will give us high temperatures, so that by the oxyhydrogen blow-pipe most of the salts and oxides are dissociated.

The metalloids bromine, iodine, sulphur, potassium, &c., are the results of the combination of two or more bodies bound together by internal forces much stronger than the affinity of hydrogen or carbon for oxygen, for approximately they obey the law of Dulong and Petit.

For higher temperatures, in order to dissociate the most refractory substances, we require the electric current, either a continuous current, as in the electric arc from a battery or a dynamo machine, or, more intense still, the electrical discharges from an electrical machine or from an induction coil.

This electric current may be regarded as the most intense furnace for dissociating large quantities of the most refractory substances, and the electric spark may be regarded as something very much hotter than the oxyhydrogen blow-pipe, and therefore of service in reducing very small quantities of substances which will yield to no other treatment. The temperature of the electric arc is limited, and cannot reach above the temperature of dissociation of the conductor, and in the case of the constant current, which will not leap across the smallest space of air unless the carbons have first been brought in contact, the current very soon ceases when the point of fusion has been reached. Yet in the centre of the arc we have the gases of those substances which form the conductor; and, as Professor Dewar has shown, we have the formation of acetyline and cyanogen and other compounds, and therefore must have attained the temperature necessary for their formation, *i.e.*, the temperature of their dissociation. The temperature of the induction spark, or, at least, its dissociating power, is higher than that of the arc. We know that the spark will pass across a space of air or a gaseous conductor, and we are limited by the dissociation of the gaseous conductor, and get only very small quantities of the dissociated substances, which immediately recombine, unless they are separated. If the gases formed are of different densities they will diffuse at different rates through a porous diaphragm, and so may be obtained separated from one another. As the molecules of bodies vibrate they produce vibrations of the ether particles, the period of the oscillations depends on the molecules of the body, and these periodic vibrations are taken up by their ether envelopes and by the luminiferous ether, and their wave-length determined by means of the spectroscope. The bright line spectrum may be regarded as arising from the vibratory motions of the atoms. As the temperature is increased, the amplitudes of oscillation of the molecules and of the ether increase, and from the calculations of Lecoq de Boisbandran, Stoney, Soret, and others, it would appear that many of the lines in the spectra of bodies may be regarded as harmonics of a fundamental vibration. Thus Lecoq de Boisbandran finds that in the nitrogen spectrum the blue lines seen at a high temperature correspond to the double octave of certain vibrations, and that, at a lower temperature, red and yellow lines are seen which correspond to a fifth of the same fundamental vibrations.

The bright line spectrum may be regarded as arising from the vibratory motions of the atoms. A widening of the lines may be produced at a higher temperature by the backward and forward motions of the molecules in the direction of the observer. A widening of the lines may also be produced by increase of pressure, because it diminishes the free path of the molecules, and the disturbances of the ether arising from collisions become more important than vibrations arising from the regular vibrations of the atoms. Band spectra, or channelled space spectra, more readily occur in the case of bodies which are not very readily subject to chemical actions, or, according to Professors Liveing and Dewar, in the case of cooler vapours near the point of liquefaction.

The effects of change of temperature on the character of spectra is very well illustrated by an experiment of M. Wiedemann with mixtures of mercury with hydrogen or nitrogen in a Geissler's tube. At the ordinary temperature of the air the spectrum of hydrogen or nitrogen was obtained alone; but on heating the tube in an air-bath the lines of mercury appeared and became brighter as the temperature rose, and at the same time the hydrogen lines disappeared in the wider portion of the tube and at the electrodes. The hydrogen or nitrogen lines disappeared first from the positive electrode and in the luminous tuft, and as the temperature rose disappeared altogether. With nitrogen in a particular experiment, up to 100° C., the nitrogen lines were seen throughout the tube, but from 100° to 230° the nitrogen lines appear towards the negative pole, and the mercury lines are less bright at the negative than at the positive pole, while about 230° C. no nitrogen lines appear. The experiments of Roscoe and Schuster, of Lockyer and other observers, with potassium, sodium, and other metalloids in vacuum tubes, from which hydrogen is pumped by a Sprengel pump, also show great changes in the molecular condition of the mixture contained in the tubes when they are heated to different temperatures. The changes of colour in the tube are accompanied by changes in the spectrum. Thus, Lockyer finds that when potassium is placed in the bottom of the tube, and the spark passes in the upper part of it, as the exhaustion proceeds and the tube is slightly heated, the hydrogen lines disappear, and the red potassium line makes its appearance; then as the temperature is increased, the red line disappears, and three lines in the yellowish-green make their appearance, accompanied by a change in the colour of the tube, and at a higher temperature, and with a Leyden jar joined to a secondary circuit of the induction coil, the gas in the tube becomes of a dull red colour, and with this change a strong line comes out in the spectrum, more refrangible than the usual red potassium line. In this case, on varying the conditions, we get a variation in the character of the spectrum, and the colours and spectra are different in different parts of the tube. In Lockyer's experiments, at the temperature of the arc obtained from a Siemens' dynamo-machine, great differences appear in different parts of the arc; for instance, with carbon poles in the presence of calcium, the band spectrum of carbon, or the carbon flutings and the lines of calcium, some of them reversed, are seen separated in the same way as mercury and hydrogen, the carbon spectrum appearing near one pole and the calcium near the other, the lines which are strongest near that pole being reversed or absorbed by the quantity of calcium vapour surrounding it. On introducing a metal into the arc, lines appear which are of different intensities at different distances from the poles, others are strong at one pole and entirely absent at or near the other, while some lines appear as broad as half-spindles in the middle of the arc, but are not present near the poles. Thus, the blue line of calcium is visible alone at one pole, the H and K lines without the blue line at the other.

We may probably regard these effects as the result, not of temperature alone, but must take into account that we have powerful electric currents which will act unequally on the molecules of different bodies according as they are more or less electro-positive. It would seem that we have here something analogous to the segregation which is observed in the melting of certain alloys to which I have already referred.

The abundance of material in some parts of the arc surrounding the central portion of it gives rise to reversal of the principal lines in varying thicknesses over the arc and poles, so that bright lines appear without reversal in some regions, and reversals or absorption lines without bright lines in others. The introduction of a substance into the arc gives rise to a flame of great complexity with regard to colour and concentric envelopes, and the spectra of these flames differ in different parts of the arc. Thus, in a photograph of the flame given by manganese, the line at wave-length 4234·5 occurs without the triplet near 4030, while in another the triplet is present without the line 4234·5.

The lines which are reversed most readily in the arc are generally those the absorption of which is most developed in the flame; thus the manganese triplet in the violet is reversed in the flame, and the blue calcium line is often seen widened when the H and K lines of calcium are not seen at all. In consequence of the numerous changes in spectra at different temperatures, Mr. Lockyer has advanced the idea that the molecules of elementary matter are continually being more and more broken up as their temperature is increased, and has put forward the hypothesis that the chemical elements with which we are acquainted are not simple bodies, but are themselves compounds of some other more simple substances. This theory is founded on Mr. Lockyer's comparisons of spectra and the maps of Angstrom, Thalèn, Young, and others, in which there are coincidences of many of the short lines of the spectra of different substances. These short lines are termed basic lines, since they appear to be common to two or more substances. They appear at the highest temperatures when the longest lines of those substances and those which are considered the test of their presence are entirely absent.

Mr. Lockyer draws a distinction between weak lines, which are basic, *i.e.*, which would permanently exist at a higher temperature in a more elementary stage, and other weak or short lines which would be more strongly present at a lower temperature, in a more complex stage of the molecules. Thus, in lithium, the red line is a low temperature line, and the yellow is feeble; at a higher temperature, the red line is weak, the yellow comes out more strongly, and the blue line appears; at a higher temperature still, the red line disappears, and the yellow dies away; whilst at the temperature of the sun the violet lithium line is the only one which comes out strongly. These effects are studied by first producing the spectrum of the substance in the Bunsen flames, and observing the changes which are produced on passing a spark through the flame; thus, in magnesium a wide triplet or set of three lines (5209·8, b^1 and b^2) is changed with a narrow triplet (b^1, b^2, and b^4) of the same character. We have here what some observers regard as a recurrence of the same harmonic relation of the vibrations of the same body at a higher temperature.

If the so-called elements are compounds, they must have been formed at a very high temperature, and as higher and higher temperatures are reached the dissociation of these compound bodies will be effected, and the new line spectra, the real basic lines of those sub-

stances which show coincidences, will make their appearance as short lines in the spectra. In accordance with this view, Mr. Lockyer holds that the different layers of the solar atmosphere may be regarded as a series of furnaces, on the hottest of which, A, we have the most elementary forms of matter capable of existing only in its uncombined state; at a higher and cooler level, B, this form of matter may form a compound body, and may no longer exist in a free state at the lower temperature; as the cooler and cooler levels, C, D, and E, are reached, the substances become more and more complex and form different combinations, and their spectra become altered at every stage. Since the successive layers are not at rest, but in a state of disturbance, we may get them somewhat mixed, and the lines at the cooler levels, D and E, may be associated with the lines of the hotter levels; these would be basic or coincident lines in the spectra of two different compounds which exist at the cooler levels, D and E. We might even get lines which are not present in the hottest furnace, A, coming into existence as the lines of compounds in B or C, and then extending among the lines belonging to more complex compounds which can only exist at a lower temperature, when they might be present as coincident weak lines in the spectra of several compound bodies. Thus Mr. Lockyer regards the calcium lines, H and K, of the solar spectrum as evidence of different molecular groupings of more elementary bodies. In the electric arc with a weak current the single line 4226 of calcium, which is easily reversed, is much thicker than the two lines H and K; but the three lines are equally thick with a stronger current, and are all reversed. With a spark from a large coil and using a condenser the line 4226 disappears, and H and K are strong lines. In the sun, the absorption bands, H and K, are very broad, but the band 4226 is weak. Professor Young, in his observation of the lines of the chromosphere, finds that H and K are strongly reversed in every important spot and in solar storms; but the line 4226, so prominent in the arc, was only observed three time in the chromosphere.

One of the most interesting features among the most recent researches in Spectrum Analysis is the existence of rhythm in the spectra of bodies, as has been shown by M. Mascart, Cornu, and others, such as the occurrence and repetition of sets of lines, doublets, and triplets in the spectra of different substances and in different parts of the spectrum of the same body. Professors Liveing and Dewar, using the reversed lines in some cases for the more accurate determination of wave-lengths, have traced out the rhythmical character in the spectra of sodium, potassium, and lithium. They show that the lines of sodium and potassium form groups of four lines each, which recur in a regular sequence, while lithium gives single lines, which, including the green line, which they show really to belong to lithium, though it was ascribed to cæsium by Thalèn, also recur in a similar way. In these three metals the law of recurrence seems to be the same, but the wave-lengths show that the whole series are not simple harmonies of one fundamental, although between some of the terms very simple harmonic relations can be found. Between the lines G and H are two triplets of iron lines, which, according to Mr. Lockyer, do not belong to the same molecular grouping as most of the other lines. In many photographs of the iron spectrum these triplets have appeared almost alone. Also the two triplets are not always in the same relation as to brightness, the more refrangible being barely visible with the spark; combining this with Young's observations, in which some short weak lines near G appear in the chromosphere 30 times, while one of the lines of the less refrangible triplet only appears once, and with the fact that in the solar spectrum the more refrangible triplet is much the more prominent of the two, Mr. Lockyer is led to the conclusion that these two triplets are again due to two distinct molecular groupings. There is one difficulty which must be taken account of in connection with Mr. Lockyer's theory with regard to the production of successive stages of dissociation by means at our command: (1) by combustion of different substances; (2) by an electric arc, which will probably give slightly different temperatures according as it is produced by different dynamo-electric machines; (3) by the induction spark without; and (4) with a condenser.

(To be continued.)

AN IMPROVED ELECTRO-MOTOR.

By T. WIESENDANGER.

(Read before the British Association, August 31, 1880.)

THE powerful impulse given to scientific research and inventive effort by the rapid progress in the development of the electric light, during the last two years, has produced the most promising results with regard to the production and employment of powerful electric currents for practical useful purposes. In these results, as already achieved, the scientific mind cannot fail to detect the embryo of a grand system of production and transmission of energy through conversion of forces, which is to supersede, in times to come, the means and methods at our command, in the present century, for generating energy through combustion. Remote as the date may be, when the vast accumulations of coal which now serve to impart life to our prime-motors shall all be consumed and the mines all exhausted, yet that epoch will and must come, as surely as our supply of combustible fuel is limited—as surely as we now consume the light and heat-producing carbons in a manner both wasteful and thoughtless. Numbers of coal-mines in this country are already abandoned, their resources being exhausted; and when the last of them is delivered up to that destruction which is brought about by time—wrought by oxidation, slow and "sure"—an important problem has to be solved: Science must then have discovered new principles, have invented new methods and novel appliances able to supersede the agencies at work in the present era, to cheer our homes with light and heat; to supply us with the vast motive energy that gives life to the thousand living mechanisms of our industries and factories.

Perhaps it is natural that our present generation should find it difficult to disassociate the idea of the generation of caloric luminous and motive energy from that of combustion, the rapid oxidation of fuel, and that the solution of the problem spoken of above is sought merely in the substitution of the consumption of a carbonaceous matter by that of some other substance.

There are powers at our command already by means of which motive energy, light, and heat can be obtained and transmitted to considerable distances; and the scientific mind has found indications, sure and certain, which create a conviction that, as the secrets of these forces are investigated, and are more and more brought to light, so the transmission of heat, as well as that of luminous and motive energy, will no longer be limited by space. Electric currents, of almost any power, can be, and are now, both naturally and by artificial means, produced independent of either slow or rapid oxidation. The friction created by wind and water—the action upon each other of different parts of the globe—

frequently have excited powerful currents of electricity unknown to and left unemployed by the human race. The tides that sweep our shores and ascend our rivers, are another grand creative source of motive energy unlimited, unemployed, and idle. Could this fertile source of energy be utilised, the difficulties in our way can be surmounted, and the energy thus obtained may, with little loss, be converted into electric currents but little limited by distance; currents powerful enough to melt our steel, to illuminate our public promenades and streets, to plough our very fields, and give life to the iron sinews of our innumerable factories.

Attempts have been made in this country to transmit the power of a waterwheel, driven by a waterfall, through the agency of the conversion of forces. A well-known gentleman succeeded, by these means, in lighting his library, and in driving machinery stationed at a very considerable distance from the prime source of energy. It was found, however, that further researches, and new discoveries and inventions, require to be made before the same process can be extensively applied to practical useful purposes.

Since then, a similar project, but on a scale far larger, has been undertaken and is being carried on in America, and should it finally prove a success, it is proposed to employ the Falls of Niagara as the central source of motive power for all the neighbouring country.

All the results hitherto obtained point to the fact, that one of the greatest difficulties met with in this field of work is the inefficiency of the dynamo-generators, and especially of the electro-motors of our present time, together with our, as yet, imperfect and fragmentary knowledge of electrical energy.

The greater the number of improvements made in the construction of the former machines, and the more deeply our scientific investigators penetrate into the secrets of this subtle force, the less remote will be the time when the transmission of motive power, light, and heat, will triumph over its greatest enemy, distance.

While recently many minds have been at work, with more or less of success, to produce improvements in dynamo-generators of electric energy, very few have given their special care and attention to the development of the electro-motor. Engineering science has taught us hitherto that the efficiencies of one and the same machine for action and reaction, or for use, either as a generator or by the inverted process as an electro-motor, stand in a certain and direct proportion to each other; or that our most efficient generators, such as the Siemens, Brush, and Gramme machines, prove also the most effective motors; and, on the other hand, that inferior dynamo-machines invariably are inefficient motors. From the results of researches I have recently made, I have come to the conclusion that the motors which are to supersede those now in use could not be employed as generators. Dynamo-machines, such as now constructed, only prove efficient when their field-magnets are able to retain, at all times (*e.g.*, even when the machine stands at rest), a certain and very considerable amount of residual magnetism, and for that reason their cores are made of retentive material—hard cast-iron—as is the case in the Brush and Gramme machines; or if the cores consist of soft iron, they are attached to large masses of hard cast-iron in such a manner that the latter are inclosed in the magnetic circuit and form part of the cores.

Generators of the same kind, when made small in size, have cores much larger and heavier in proportion; and, moreover, the base-plate, or, as in the Weston machine, a heavy retentive cylinder, is made to form a portion of the field-magnets.

But all effort hitherto made to produce efficient small dynamo-machines with cores of soft iron only, have resulted in absolute failure, although men of the highest genius have made repeated and prolonged efforts to solve that most difficult of problems.

These curious facts conclusively prove that the theory explanatory of the action of dynamo-machines, as now universally adopted, viz., the theory of inductive action and reaction between the field-magnets and the armature, cannot any longer be considered complete or satisfactory; for even wrought iron, especially when occurring in large masses, always contains an appreciable amount of residual magnetism, more especially after it has once been subjected to strong magnetisation; and if the above theory were correct and complete, then the smallest possible amount of residual magnetic energy, augmented by repeated action and reaction, would be sufficient for the starting of such a machine to action. This, however, experience proves *not* to be the case, and the theory, although stoutly adhered to, must be either abandoned or amended.

The inventors of the most recent electro-motive engines have worked, perhaps unconsciously, upon the idea that the construction and action of electro-motors are based altogether upon the same laws as those of dynamo or magneto-machines, and, in accordance with that assumption, the field-magnets of the Deprez motor are made to consist of large and heavy masses of magnetised sheet.

Experimenters have also for a long time past clung to the idea that the efficiency of an electro-motor, or the amount of energy to be obtained from such a machine by means of a current of given strength circulating in the coils of its armature only, bears a definite and direct proportion to the magneto-inductive power of its field-magnets, and that an increase of power in the field-magnets alone must necessarily produce greater capabilities of the machine. This is a mischievous theory and erroneous in its very principles, and its development would only lead to the hypothesis of perpetual motion. On the contrary, starting from a consideration of the fact that a very small magnetic needle, if acted upon by one of the poles of another and very powerful magnet, has its polarity destroyed or reversed, and that if one of its poles, say the N pole, is presented to a similar (N) pole of the large magnet, the former will completely lose its attracting qualities and be attracted by its overpowering opponent, one can only come to the one natural conclusion—that the power of the field-magnet for electro-motors, as compared to that of the magnet or magnets constituting the machine, should vary as the limit of some certain ratio, to be determined yet by experiments carefully conducted, and that if we pass that limit the capabilities of the machine must be impaired. Acting on this principle I have constructed a machine in which the power of the field-magnets is as nearly as possible equal to that of the armature. The cores of the former are very light, and are made entirely of soft iron, and the satisfactory results obtained from this machine are a sure sign that further investigation on the subject and improvements made with the view of determining the proportion of power between the magnets and armature will result in further improvements.

Another and very important consideration in the construction of dynamo-machines and electro-motors has not yet received that care and attention from scientific investigators which would lead to immediate progress. It is the method of motion of the revolving armature with regard to its approaching to, or receding from, the poles of the field-magnets. In nearly all the machines now constructed the polar faces of the cores of the field-magnets, and those of the armature, are of such a shape, and the latter is caused to revolve in such a manner, that

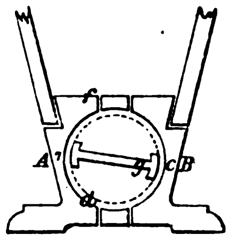


FIG. 1

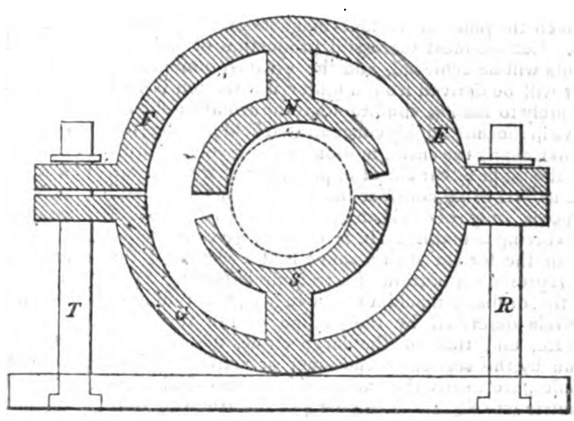


FIG. 4.

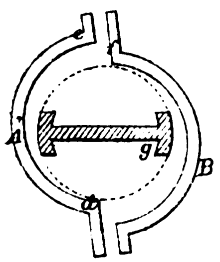


FIG. 2.

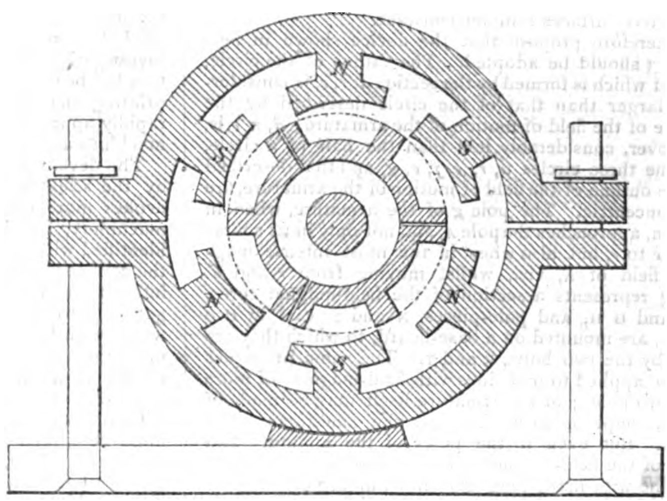


FIG. 5.

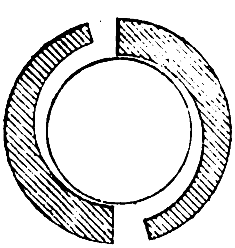


FIG. 3.

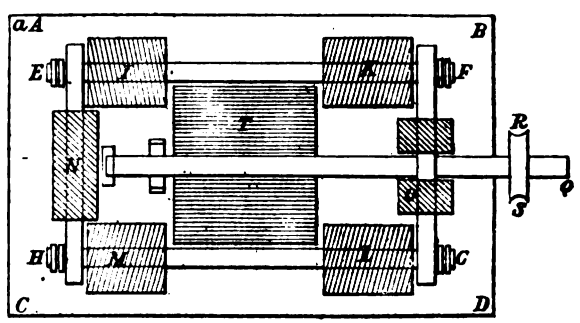


FIG. 6.

only in a small portion of the revolution its poles either approach the poles of the field-magnets or recede from them. But the most successful production of induced currents will be achieved, and the greatest amount of power will be derived from a motor, if attention is paid not merely to the *one* conditionthat the armature should revolve in the most highly concentrated field possible, but also that nearly the entire motion of the revolving armature should be either one of approach or of withdrawal.

Let us first of all consider the case of a machine with two poles only of field-magnets and two poles of the revolving armature. It is usual to give the active facial of the former such a shape that a section of the same represents a portion of a true circle (see fig. 1).

In the ordinary machines now in use, the radius of the circle described by the outline of the revolving armature, and that of the large circle, described in portion by the section of the inner or active facial of the poles, are nearly the same, and the two circles are concentric (see fig. 1). The pole *g* of the armature only approaches the pole A of the field-magnet while moving from *c* to *d*, or where the intensity of the magnetic field of A is at its minimum. When continuing its motion from *d* to *r* and to *f* the pole *g* can no longer be said to approach A, because the distance between the respective surfaces remains constant.

I therefore propose that the device shown in figs. 2 and 3 should be adopted. The radius of the circle, part of which is formed by the section *d*, *r*, *e*, is considerably larger than that of the circle described by the outline of the field of motion of the armature; *d*, *r*, *e* is, moreover, considerably less than the half of a circle, and the three circles *d*, *r*, *e*, *f*, *e*, *g*, and that described by the outline of the field of motion of the armature, are *not* concentric. The pole *g* of the armature, when in motion, approaches the pole A, and not only in its course from *e* to *r*, but also when in the most intense magnetic field of A, viz., whilst moving from *r* and *d*. Fig. 4 represents a section of the field-magnet cores, E F and G H, and pole-pieces, N and S, cast in two halves, are mounted on a base-board, to which they are fixed by the two bolts, R and T. The same principles may be applied to machines with field-magnets of more than two poles; or the armature itself may be made of such a shape as to work under the conditions above stated. But even if the poles of the armature and those of the field-magnets are of the ordinary shape, a machine with many magnets will be more perfect in its action than one with field-magnets of two poles only. Fig. 5 illustrates a machine in which the armature during nearly the whole of its motion either approaches to, or recedes from, the poles of the field-magnets. In such machines the motion of the poles of the armature is also more in a line coincident with the line of attraction as exercised between the two systems of poles, while in machines with field-magnets of two poles only the motion of the poles of the armature is at times at angles of 45 degrees to 1 degree from the direct pull.

I may, perhaps, be allowed to call attention to another matter of importance awaiting further research. We find that in the three types of dynamo-machines, as constructed by Siemens, Gramme, and Wilde, the relative positions of the axis of the field-magnets and those of the armature are altogether different. Yet the three systems work well. We are unable, however, to state with certainty which arrangements of the axis are the best, or why any one of these inventions should be better than the others, and, in the face of experience, the theory of tubes or lines of force is little more than a hypothesis with all its diffusion, vagueness, and uncertainty.

Having so far considered general principles chiefly, I now beg to describe this motor. A B C D (fig. 6) is a wooden base-board, E F G H a frame, consisting of the two parallel round rods, F E and G H, and the two flat bars, F G and E H, made of the best wrought iron and carefully softened. The four bars are screwed together at the corners and supported by four brass brackets over the base-board. These four iron rods form the compound core of the field-magnets, a combination, as it were, of two horseshoe magnets, whose similar poles, S S and N N, form the junctions, thus we have practically two poles only, a S and a N pole. Six coils of insulated copper wire are wound over the different portions of this core, shown in the drawing; the active pole-pieces are left exposed for a long distance, bearing no coils. The spindle Q, which carries a Siemens armature of the old form, or an armature with a compound tubular core, and also the commutator and the pulley, R S, traverses the flat cross bar F G. The core of the armature is made of sheets of charcoal-iron, and it bears a coat of stout insulated copper wire. The commutator is of the ordinary kind, consisting of two half-tubes of brass, insulated from each other and from the spindle, and each forming one of the terminals of the coil.

The development of most important machines is destined to reach a certain stage of perfection when further improvements cannot be accomplished by the inventor unaided, the second and important factor needed then is the co-operation of inventive and investigative talent with capital. This stage of perfection has been reached in the steam engine, gas engines, printing machinery, &c., and it may be said to be rapidly approached by the progress made in dynamo-machines and electro-motors.

The development of the latter machines is followed by the scientific world with greater interest, and it evokes more eager expectations than that of other machinery, chiefly because it is not and cannot be identified with the solution of a problem limited within the confines of mechanical difficulties and commercial interests, but it necessitates a further and deeper investigation into that great and subtle power, electricity, whose manifestations are so striking in their effects, so mysterious in their nature, so promising of great results in an immediate future, so fertile a field of research to the pioneer of science.

Combined with this is the interest which of necessity must be attached to the efforts at the solution of a national problem, nay, one of international and universal moment, and one at which our ever-active trans-Atlantic kinsman has worked to so great credit. Who will be the winner in this meritorious competition? Of higher moment even than the answer to this question ever can be is the consideration that by the work done in trying to solve the great problem, new efforts will be made in scientific research, new principles discovered, new inventions made, and more light will be thrown over fields of intellectual work hidden, even now, in darkness, doubt, and mystery.

ON THE PROPER FORM OF LIGHTNING CONDUCTORS.

By WILLIAM HENRY PREECE.

(Read before the British Association, Aug. 27, 1880.)

A LIGHTNING conductor erected for the protection of a building consists of a ribbon, rod, chain, rope, or other mass of metal attached to the highest point of the structure, and descending to the earth. What shall be the form of this conductor? has been a vexed question from the days of Franklin to the present. Shall it be dependent on extent of surface or on sectional area? In other words, does the transference of electricity

when the potentials are so high as to cause lightning discharges, obey the law of Ohm, or is this law modified by the presence of some fresh condition? Snow Harris was a very warm advocate of the surface form. He used flat ribbons for his ships, and tubes for his buildings. Henry, of Washington, believed in the efficacy of surface. According to him, frictional electricity passes at the surface, galvanic electricity through the mass.* M. Melsens is found on the same side, and Guillemin, of Paris, led many French electricians to favour the same view.

On the other hand, Faraday almost angrily espoused the opposite side. "As respects electrical conduction," said he, "no advantage is gained by expanding the rod horizontally into a strap or tube. Surface does nothing; the solid section is the essential element."

The advocates of the solid and cylindrical form argue that the lightning conductor is simply a path by which electricity is transferred from a point of high potential (an electrified cloud) to a point of lower potential (the earth), and that its efficacy depends solely upon its resistance. It obeys the law of Ohm, and its efficacy is therefore for the same material dependent on its mass and sectional area.

The advocates of surface argue, that as in all cases of static charge electricity exists only on the surface, so when electricity of "high tension" is conducted away it is the surface that plays the prime part, and, therefore, the greater the surface the easier the path to the discharge. Again, they say when a cylindrical conductor conveys a charge of electricity it is raised to a "high tension," and is rendered capable of doing mischief; but with the same charge, the greater the surface the less the density on the surface, and, therefore, the greater the safety. In other words, with a given quantity of electricity, the greater the surface the less the potential. Moreover, they urge, since according to Guillemin currents of electricity flowing in the same direction retard each other with a power varying with the distance separating them, and since a rod may be considered as a bundle of smaller but parallel rods, so a current of electricity may be considered as being made up of many parallel currents, each retarding the other. Hence, a ribbon will conduct better than a rod, because the currents are spread further apart, and retard each other less. These arguments have led to the employment of unsightly ribbons and expensive tubes, which have considerably interfered with the establishment of this very necessary element of safety to buildings.

The arguments in favour of the surface form are, in the opinion of the author, deductions from exploded theories, from imperfect experiments, or from erroneous interpretations of well-ascertained facts. No direct experiments have ever been made to solve the question, as far as the author knows. Quantities of electricity, that is, static discharges from condensers, are in incessant use for telegraphic purposes, and are found to follow exactly Ohm law, even with the most delicate apparatus. The knowledge of the flow of electricity through conductors, of the retarding influence of electrostatic capacity upon this flow, and of the distribution of charge, has become so much greater of late years through the great extension of submarine telegraphy and the labours of Sir William Thomson, Clerk-Maxwell, and others, that I question if any English electrician would now be found to argue in favour of the surface form. Nevertheless, ribbons and tubes still continue to be used, and it appeared very desirable to settle the question experimentally. I determined to try and do so.

* *Telegraphic Journal*, October 15th, 1877.

First Experiments, June 28, 1880.

Dr. Warren de la Rue, who is always ready to place his splendidly equipped laboratory at the service of science, not only allowed me to use his enormous battery and his various appliances, but aided me by his advice, and assisted me in conducting the experiments.

Copper conductors, 30 feet long, of precisely the same mass (*a*), drawn into a solid cylinder (*b*) made into a thin tube, and (*c*) rolled into a thin ribbon were first of all obtained. The source of electricity was 3,240 chloride of silver cells. The charge was accumulated in a condenser of a capacity of 42·8 microfarads. It was discharged through platinum wire of ·0125 diameter, of different lengths. The sudden discharge of such a large quantity of electricity as that contained by 42·8 mf. raised to a potential of 3,317* volts is very difficult to measure. It partakes very much of the character of lightning. In fact the difference of potential per unit length of air is probably greater than that of ordinary lightning itself. It completely deflagrates 2½ inches of the platinum wire, but by increasing the length of the wire it could be made to reproduce all the different phases of heat which are indicated by the various shades of red until we reach white heat, fusion, and deflagration. Hence the character of the deflagration, which is faithfully recorded on a white card, to which the wire is attached, by its scatttered particles, is a fairly approximate measure of the charge that has passed, while the length of wire, raised to a dull red heat is a better one, for any variation in the strength of the current within moderate limits is faithfully recorded by the change of colour.

Experiment 1.—Similar charges were passed through the ribbon, tube, and wire, and in each case 2½ inches of wire were deflagrated. No difference whatever could be detected in the character of the deflagration.

Experiment 2.—Ten inches of wire were taken and similar charges passed through. In each case the wire was raised to very bright redness, bordering on the fusing point, and in two cases the wire broke. In each case the wire knuckled up into wrinkles, and gave evidence of powerful mechanical disturbance. The same wire was not used a second time. No difference could be detected in the effect through the different conductors.

Experiment 3.—Silver wire of the same diameter and length was used, and similar charges transmitted through it. Redness was barely visible, but the behaviour of the wire was similar in each case.

The conclusion arrived at unhesitatingly was that change of form produced no difference whatever in the character of the discharge, and that it depended simply on mass.

Second Experiments, July 19, 1880.

As it might be urged that the length of conductor tested was so short, and its resistance so small that considerable variations might occur and yet be invisible, similar lengths (30 feet) of lead—a very bad conductor, its resistance being twelve times that of copper—were obtained, drawn as a wire, made as a tube, and rolled as a ribbon, each being of similar weight.

Experiment 4.—Charges from the same condenser, 42·8 mf., but with 3,280 cells, were passed through, and the discharges observed on 6 inches of platinum wire 0·0125 inches diameter, which in each case was heated to bright redness. No variation whatever could be detected, whether the wire, the tube, or the ribbon were used.

* The electro-motive force of the chloride of the silver cell is 1·03 volt.

Experiment 5.—In order to form some idea as to how closely we could estimate any variation in the character of the discharge, we used a long piece of platinum wire and adjusted the lengths until we obtained just visible redness; then a diminution of 10 per cent. (3 feet) produced a marked change to dull redness, and further excisions raised the temperature to brighter and still brighter red.

The conclusion arrived at was that any change in resistance of 5 per cent. would have been clearly and easily discernible.

It therefore appears proved that the discharges of electricity of high potentials obey the law of Ohm, and are not affected by change of form. Hence, extent of surface does not favour lightning discharges. No more efficient lightning conductor than a cylindrical rod or a wire rope can therefore be devised.

ELECTRIC MINE EXPLODERS.

SIEMENS' APPARATUS.

(*Continued from page* 275.)

The small quantity-exploder is of the same construction as the large one, but its weight, including knapsack, is only 39 lbs. It fuses a quarter of an inch of 0·0015 inch iridio-platinum wire through a line resistance of 50 Siemens' units. With short leading-wires this exploder heats 8¾ inches of iridio-platinum wire of 0·0015 inch diameter, which is equal to about 35 Service Detonators, No. 13. Dimensions of the exploder, 12″ × 11″ × 6″.

With a given electro-motive force the quantity of current passing through a circuit per unit of time depends upon the resistance of the circuit, hence, if only one quantity-fuse be connected up with the exploder, a stronger current will be generated than when several fuses are joined in series. Thus, with a small exterior resistance, a large quantity of current passes from the armature into the electro-magnets of the machine, whereby a very powerful magnetic field is formed and the revolving armature experiences a resistance to its motion, which may become so great as to render the turning of the handle of the machine difficult. In order to overcome this inconvenience as much as possible, an extra coil of several units resistance is inserted in the base of the instrument. This extra coil may be increased in resistance 10 or 20 units if the machine be required to turn with greater ease. When the firing-key is at rest, the extra coil is in circuit with the electro-magnet coils, but when the key is depressed the extra coil is cut out, and the line and fuses put in circuit.

The only reliable test of the efficiency of tension-exploders is length of spark, as, owing to the great difference in the resistance of tension-fuses, any standard of efficiency based upon the number of such fuses an exploder will fire must be incorrect. The test for the quantity-exploder is the length of iridio-platinum wire of a standard diameter which can be fused.

The nature of electricity of great electro-motive force, by which it overcomes high resistances, requires that the coating of the cable or conducting wire should have high resistance, or, in other words, be well insulated, in order to prevent escape of the electric current. It should be borne in mind that to "insulate a wire" means to surround the wire with a covering which offers sufficient resistance to the escape of the electric current, and, consequently, that the greater the electro-motive force the greater is the resistance required in the insulating covering.

In cases where the conducting wires are for the greater part of their length stationary, high tension electricity is to be preferred, because its greater power of overcoming resistance enables it to fire a larger number of fuses through longer distances. On this account the tension-exploder is better suited to mining purposes, where fuses have to be exploded either in numbers *simultaneously* or through *long* circuits.

But in cases where only short lengths of conducting wires are employed, and these are frequently shifted or subjected to such rough usage as would endanger the insulation of the cable, the use of electricity of *small* electro-motive force is advisable, for this will pass without loss through a cable with faults in the insulation through which currents of greater force would readily escape. On this account the quantity-exploder should be employed.

The mistake of using weak machines has done much to hinder the adoption of electrical firing.

The dynamo-exploders are unquestionably the most suitable for blasting, and of the two kinds of apparatus the tension-exploder is usually preferred in consequence of tension-fuses being cheaper than platinum wire-fuses. When, however, a system of mines has to remain a long time inoperative, and yet in a condition to be fired at a moment's notice, daily electrical tests must be taken, and this can only be done when platinum wire-fuses are used.

There are two kinds of fuses adapted to the two kinds of electric-exploders, viz. :—

(*a*) Tension fuses.
(*b*) Quantity fuses.

Tension-fuses should be made of stable elements, so that no chemical decomposition can take place in the priming, and the fuses must remain unaffected by moisture and heat, even when used in tropical climates. The composition of tension-fuses should likewise keep unchanged during a long sea voyage, as many failures in electric blasting abroad have been due to a chemical change in the fuses or to the mass of the priming having become loosened during transport. It is important, in connecting up the fuses in circuit for firing, that great care should be taken not to put too much strain upon the fuse wires, otherwise these wires are apt to be pulled out of the explosive compound, and the fuse cannot then explode. The data given below respecting the number of fuses fired by Siemens' exploders refer to Abel's fuses only.

When a number of fuses are joined in single circuit the resistance of each fuse is added to that of the entire circuit, but when connected in divided circuit the joint resistance of the fuses is less than that of a single one only. In cases where an unusually large number of *tension-fuses* are required, the *divided circuit* may be used, but the connections are *troublesome* to make, and as a sufficient number of fuses can be fired in *single* circuit, this latter

method is preferable for quantity as well as tension-fuses.

The following are some results obtained with the large dynamo-electric exploders :—

Fuses connected in single circuit.

Fifty fuses fired with large tension-exploder.

Fuses arranged in divided circuits, three groups of six fuses each. (Fig. 4.)

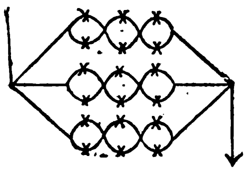


FIG. 4.

All eighteen fuses fired with large tension-exploder.

Fuses arranged in three groups of ten. (Fig. 5.)

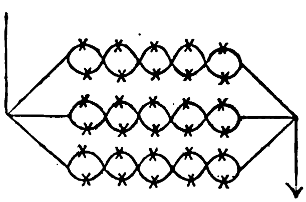


FIG. 5.

All thirty fuses fired with large tension-exploder.

Fuses arranged in fourteen groups of five each. Sixty-one fired out of the seventy.

Single fuse firing with platinum wire-fuses.

One fuse of wire 0·03 mm. diameter exploded through 140 Siemens' units resistance, with large quantity-exploder.

Fuses connected in single circuit :—

Forty-four service detonators, No. 13, exploded with large quantity-exploder.

Thirty-four service detonators, No. 13, exploded with small quantity-exploder.

The heating power of the large quantity-exploder is such that, with a platinum-wire weighing 1·65 grains per yard, 6½ inches can be fused on short circuit and 14 inches were heated to redness.

If more than one charge is to be exploded, three or four tension-fuses may be placed in each, and the groups of fuses connected to the main leading wires in the manner shown in fig. 6, which shows three groups. But care should be taken not to place more fuses in circuit than the apparatus can with certainty explode.

If only one charge is to be exploded, the fuses should be connected up in single circuit, so that the current may pass through one fuse after the other.

The earth may be used in place of one of the leading-wires. In this case it is necessary to provide two *earth-plates*, one of which is to be buried in *damp* earth near the mine to be exploded and connected by a wire with the fuse, the other to be buried near the machine and connected by a wire with one of the connecting screws, *e*. The earth-plates should measure at least 3 ft. by 2 ft., and be of copper. If the earth is not naturally moist it must be made so with water; but, as a rule, *earth-plates are not recommended* for the return of the current, owing to the difficulty of getting a reliable earth-connection which will not considerably increase the electrical resistance of the circuit.

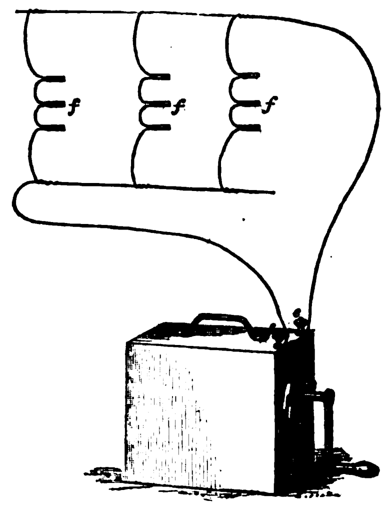


FIG. 6.

In the case of a cable having a metallic sheathing, this latter may be used instead of earth-plates as a return wire; care must, however, be taken to make good metallic connection with the wires which connect the cable sheathing to the fuses and to the machine.

The leading-wire or cable conductor, best adapted to the various kinds of work to which the exploders are more generally applied, consists of a three-strand tinned copper wire, insulated with three layers of india-rubber, taped with cotton saturated with india-rubber, of which fig. 7 is a section.

FIG. 7.

FIG. 8.

As the insulation of an unprotected leading-wire is likely to suffer damage from rough usage in mines, an iron sheathed cable is preferred. This consists of a strand of copper wire covered with gutta percha, similar to that just described, also with a serving of tarred jute, and sheathed with iron wires. See fig. 8.

For military and submarine mines the size of the cable required depends very much upon local conditions; a variety of cables are therefore in use.

For connecting the main cable with the fuses and shot-hole wires thin gutta-percha or india-rubber-covered wires are used.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XVI.

THE A B C INSTRUMENT.

THIS instrument is extensively used at small stations where the amount of traffic is not sufficiently great to warrant the employment of the single needle apparatus, and a trained clerk for working the same. The A B C is also very largely used for private purposes; indeed, it is only since the telegraph system of the United Kingdom has been worked by the State that it has been employed for the transmission of public messages. The use of the instrument is now so extensive that over 5,000 are at present required for carrying out the work for which they are specially fitted.

Since the first invention of the instrument by Wheatstone in 1848, various improvements have been effected, so that at the present time it is undoubtedly the most perfect apparatus of the kind yet brought out; and its construction and action are marvels of ingenuity and mechanical design.

The apparatus consists of two parts—viz., the "Communicator" and the "Receiver."

By means of the Communicator electro-magnetic currents are generated and controlled. Fig. 64 shows the current-generating arrangement, which is remarkable for the regularity of its action. M is a strong compound horseshoe permanent magnet, upon the poles of which are fixed the electro-magnets, A A_1 and B B_1. The poles of the permanent magnets being set midway on the cross pieces, *b* and *c*, of the electro-magnets, induce in the two soft iron cores of each of the latter, similar and equal polarity—that is to say, the soft iron cores, N N_1, of the bobbins, A A_1, have similar and equal polarity, whilst the cores, S S_1, of the bobbins, B B_1, have also similar and equal polarity. But the polarity of the cores, N N_1, is the reverse of that of the cores, S S_1. In front of, and in close proximity to, the poles of the electro-magnets, a soft iron armature, F F, is placed. This armature is fixed on an axle, *a, g*, by means of which it can be rotated. The result of this rotation is as follows:—If an armature is placed on the poles of an ordinary horseshoe permanent magnet, the latter magnetises the armature by induction, and the armature so magnetised reacts back on the poles of the magnet, and increases their power; this increased power in turn reacts back on the armature and increases the power of the latter, and so on. Thus, by a series of reactions, which are almost instantaneous, the magnetic strength of the poles of the magnets becomes considerably increased; or, in other words, the magnetism of the magnet becomes concentrated at the poles. Now, the effect would be the same if the poles were provided with soft iron prolongations. In this case, if the armature were placed on the ends of these prolongations the latter would have a considerable amount of magnetism concentrated on them. On withdrawing the armature, the increase or concentration of the magnetism would cease. If now coils of wire are placed round the prolongations, so that electro-magnets are formed, then the increase and decrease of the magnetic strength will induce currents of electricity in the coils; the direction of the current when the armature is approached being in the reverse direction to that induced when the armature is receded.

In fig. 64 it will be noticed that the armature, F F, is lying in close proximity to the cores, N S_1, of the bobbins, A B_1. If now F F be rotated a quarter of a circle so as to leave the poles of the cores, N S_1, and to cover the poles of the cores, S N_1, then the retrocession of the end of the armature from N will weaken the magnetism in the latter, and will induce a current in the coil, A, in one direction; the approach of the armature to S will increase the magnetic strength of the latter and will induce a current in the coil, B, which will be in the *same* direction as that in the coil, A, for *in*crease of *southern* polarity produces the same direction of current as does the *de*crease of *northern* polarity. Considering still the same end of the armature, if the latter be rotated another quarter circle, we shall have the core, S, decreasing in magnetic strength whilst the core, S_1, increases in strength, thus S and S_1 being of like polarity, the current in the coil, S_1, will be in the reverse direction to that in the coil, S, but as the connection between S and S_1 is crossed, the current in the circuit will be in the same direction, though it will be the reverse of those which were induced when the end of the armature passed from N to S. Similar actions take place in the coils under the influence of the other end of the armature which it is unnecessary to consider, but if they are traced out it will be seen that the connections of the various coils to one another is such that the currents in the entire circuit, when the armature turns through each quarter revolution, will be in the same direction, and also that the entire direction is reversed at each alternate quarter revolution. By rotating, therefore, F F rapidly, a series of rapidly reversed currents will be sent out by the coils, A A_1, B B_1.

As the strength of these currents depends upon the degree of change in the magnetic strength in the cores, N N_1, S S_1, and as this amount of change depends greatly upon the proximity to which the armature, F F, can be brought to the poles of the cores, great care is taken in the surfacing of the armature and the pole faces so that they can be as close as possible in all positions without actually touching.

The magnetic pull on the armature, F F, naturally causes considerable pressure of the end, *g*, of the axle upon its bearing, the latter is therefore jewelled so that as little friction as possible is produced. In order to relieve this pressure and reduce the friction as much as possible, the driving wheel, W (by which the pinion wheel, *w*, fixed on the axis *a*, of the armature, is driven), has its teeth cut diagonally, the teeth of *w* being similarly cut to correspond. The result of this is, that when the wheel, W, is turned in its normal direction, that is, in the direction in which the hands of a watch turn, the inclined teeth tend to make the axle slide away from its jewelled bearing, and thus to take the pressure off. Great ease of turning is produced by this simple device.

The Receiver.

Before considering how the currents produced from the generator are controlled, and the general construction of the Communicator, it will be as well

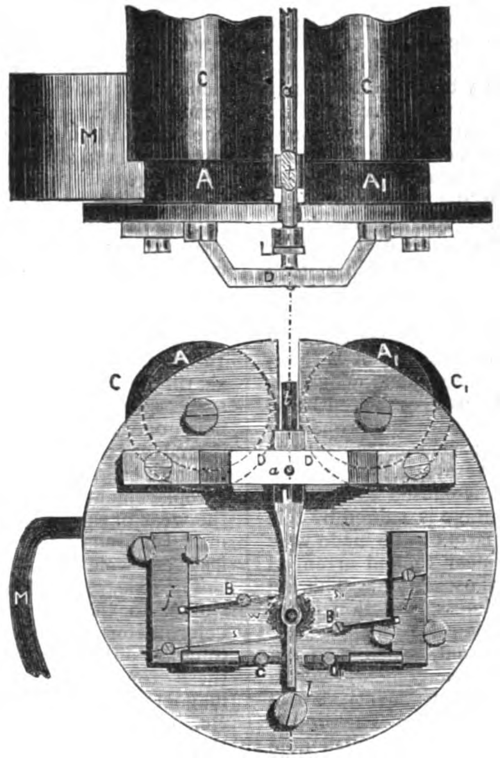


Fig. 66.

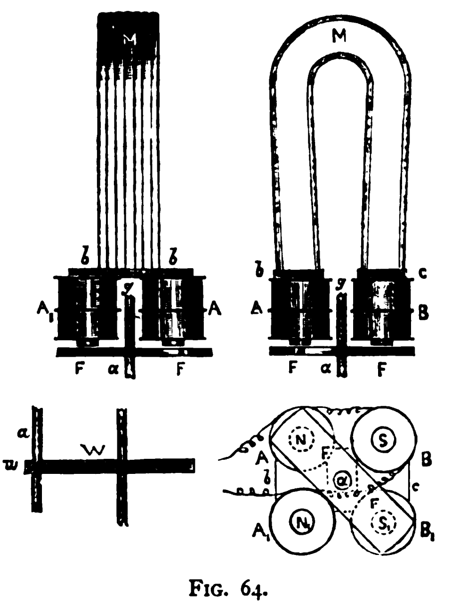


Fig. 64.

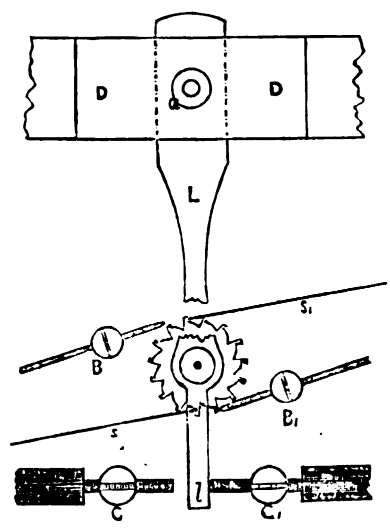


Fig. 65.

to see how the currents can produce the motions of the indicator hand.

The effect of a series of rapidly reversed currents sent through an ordinary polarised relay is to cause the tongue of the latter to vibrate rapidly to and fro. If the construction of the relay is such that its tongue is light, well-balanced, and can vibrate freely without much obstruction, the vibrations will correspond exactly with the succession of currents, even though the latter follow one another at a considerable speed. The form of relay which fulfils these conditions most satisfactorily is the Post Office Standard form, which was described in Article V., p. 101 (March 15th), and it is this form of apparatus which is used for working the receiving portion of the Wheatstone A B C apparatus. To work the hand round the dial, letter by letter, a ratchet wheel is attached to the axle of the dial hand, and this is actuated by spring pallets. In every other form of A B C instrument but the Wheatstone the pallets which actuate the ratchet wheel are themselves moved backwards and forwards by the action of the propelling electro-magnet. In the Wheatstone instrument the reverse is the case, that is to say, the pallets are fixed, and the ratchet wheel is caused to oscillate against them. A great advantage is gained by this arrangement, as the moving parts can be made very light, and their mass be set near to, and arranged uniformly around, the centre of oscillation. This is a very great point when quickness of action is required.

The principle of the propelment, which is an extremely beautiful mechanical arrangement, may be understood from fig. 65, which is a general plan of the mechanism drawn to double scale. The propelling wheel has its axle pivot set in a jewelled hole in the lever, L l; this lever is fixed on an axle at a, so that it can oscillate between the two limiting screws, C C_1. The axle of the ratchet wheel is about 2½ inches long, and its further end passes through a jewelled bearing, and to its end is fixed the indicating hand. The comparatively long length of the axle allows of an oscillating movement being given to the ratchet wheel without causing the axle pivots to jam in their bearings, although they fit without much shake in their jewelled holes.

The teeth of the ratchet wheel it may be seen are cut in a peculiar manner. The springs, $s\,s_1$, normally rest against the backs of the projecting portions of the teeth; these projecting portions are slightly "undercut," so that the springs cannot be jerked up out of gear with them. The fronts of the teeth bank in succession against the limiting stops, B B_1, when the lever, L l, is oscillated backwards and forwards. Referring to the figure, if the lever, L l, be be moved to the left then the spring, s, being against a tooth, will cause the wheel to rotate slightly in the reverse direction to that in which the hands of a watch turn, until the face of the tooth which is banking against the spring, s_1, comes against the screw stop, B. When this movement is complete, the spring, s_1, will have dropped behind the tooth in the rear of the one against which it is represented as banking in the figure; if now the lever, L l, be moved to the right the spring, s_1, will cause the wheel to rotate a step further until a tooth banks against the screw stop, B_1; thus each oscillation causes the wheel to turn through a small angle, the distance actually turned through being equal to half the distance between two teeth. Although the screw stops, B B^1, theoretically will limit the motions of the wheel, and also of the lever, L l, the screw stops, C C_1, practically limit the movements of the lever, and relieve the pressure which would otherwise have to be borne by the teeth alone. The adjustment of the arrangement in, fact, would be made by the springs, $s\,s_1$, and the screws, B B_1, in the first instance, and then the screws, C C_1, would be set so as to slightly lessen the play of the end of the lever.

As the springs, $s\,s_1$, occasionally get broken their replacement is facilitated by having them fixed to removable pieces of brass, $f\,f_1$, (fig. 66), which are each held by two screws, between which they can be slid and fixed; the correct adjustment of the springs is thus easily made.

The ends of the springs, $s\,s_1$, which bank against the teeth of the wheel should not be left jagged or sharp, but should be carefully rounded on an oil-stone, so that a smooth end is produced; if this is not done the chisel-like action of the sharp or jagged ends will, in a short time, cut off the projecting portions of the teeth of the wheel, rendering a replacement of the latter necessary. To render the wear of the wheels as small as possible they are manufactured of German silver, which is found to last very well.

The axle, a, to which is secured the lever, L l, is similar to that in the Post Office Standard relay before referred to, being provided with soft iron tongues, one of which, t, can be seen in the figure; these tongues are polarised by the permanent magnet, M, and play between the pole pieces, A A_1, &c., of the electro-magnets, C C_1. Fig. 66 shows the actual size of the mechanism.

Notes.

Mr. H. C. Fishe, of Springfield, Mass., has lately patented a Dental attachment for telephones, by means of which persons having defective hearing can hear. The arrangement consists of a link of rigid sound-conducting substance, such as wood or hard rubber, connected with the centre of the diaphragm, or with a disc attached to the centre of the diaphragm, and is supported by an elastic fulcrum attached to the mouth-piece of the telephone. The further end of this link is held by the teeth of the deaf person, and the vibrations can thus be transmitted to the auditory nerves. The under surface of the link is provided with an elastic coating which prevents the vibrations from affecting the teeth of the lower jaw.

The phenomenon lately discovered by Hall of the action of a magnet in altering the path of a current of electricity in the conductor which carries it, has formed the starting-point for two investigations, which have appeared separately in the *Wiener Anzeiger*, by Boltzmann and Von Ettingshausen respectively, in which they point out that this discovery may be applied to determine the absolute velocity of electricity in a conductor.

Electric Lighting. — The works at the new reservoir, Bradford, are being lighted by two of Mr. Crompton's lamps, so that the labour goes on continuously.

The Edison electric lamp, it is stated, has been tried with success on the Oregon Railway and Navigation Company's steamship *Columbia* during a recent voyage.

It is proposed to utilise the Canadian Pacific Railway as part of the route for a new telegraph line from Europe to Asia, to be entirely under English control. The terminal station will probably be Hong-Kong.

At the present time there are over 6,000 miles of wire in use for telephonic purposes in the United States.

M. Clémandot employs slag wool for diffusing the light in electric lamps in the place of ground or opal glass; the material is placed in tubes, and is more or less lightly packed according to the degree of opacity required. These tubes form the sides of the lantern within which the electric light is placed.

On the 12th instant a brilliant display of Aurora borealis was observed in several parts of the United Kingdom, and during the day strong earth currents were found to exist on several of the telegraph lines, the strength in some cases being so great as to interrupt the working of the lines. In connection with this "magnetic storm," we may mention some curious and interesting facts which have been brought to our notice as regards the distribution of these earth currents. On the day on which the disturbances were observed, it was noticed that strong earth currents traversed the 1871 Marseilles-Algiers Cable, whilst on the 1879 cable, which runs parallel to the former for the entire distance, no disturbances occurred. On the Marseilles-Barcelona Cable, earth currents were also observed; further, it was noticed that similar currents existed on the Lisbon-Vigo cable of the Eastern Telegraph Company, whilst on the cable which runs parallel to it for a considerable distance, and which extends to the Land's-end, no currents were observable. Again, on the overland line between Bilbao and Madrid, strong currents interfered with the working, though no trouble was found on the lines running north of Bilbao. Now the existence of a current on a line indicates a difference of potential between two points. Since no current existed on the 1879 Marseilles-Algiers Cable, the potential at the two terminal stations must evidently be equal. The fact of a current existing on the 1871 cable would seem somewhat difficult to account for if it did not happen that at a distance of 70 miles from Marseilles a fault existed in the cable; at this point then the potential of the earth must have been different from the points north and south of it. The existence of the current in the Eastern Company's Cable is similarly accounted for, since a fault exists in this cable not far from Lisbon. A straight line joining the faults in the two cables in question, curiously enough, passes through Madrid and also through Barcelona. From these facts it would seem that a distinct line of potential existed during the time the disturbances existed, the value of which was different from the potential a short distance north or south of it. It would be interesting to know whether this line or belt of high or low potential extended beyond the limits pointed out, and if so, whether its direction deviated to the right or left. The direction of the line, curiously enough, was almost exactly magnetically east and west.

We understand that the Postal Telegraph Department has become the purchaser of the business and premises of Mr. Stroh in the Hampstead-road. Much comment is made as to the wisdom of the policy of the Post-Office Department in manufacturing for themselves instead of putting their requirements up for tender by the best manufacturers. It must, however, be borne in mind that the manufactory lately Mr. Stroh's contains all the special appliances he has had made and has constructed for the making of the Wheatstone apparatus, of which the department is likely from time to time to require more.

The electric light is now progressing most hopefully, its use for advertising purposes, as at rinks, music halls, &c., having died out, and its general commercial application being made even more and more increasingly apparent.

Mr. Rapieff's light at the *Times* office has been still further extended, there being 31 lamps now in use, viz., 3 in the imposing room, 1 in the hall, 8 in the south composing room, 6 in the north ditto, 4 in the reading room, 3 in the composing-machine room, and 6 in the machine room.

The new office of the *Guardian* at Warrington is being fitted up by the British Electric Light Company. The building is peculiarly adapted for the electric light, as it is but one storey, covers a space 150 by 93 feet, and has its inside walls lined with white glazed bricks, which will materially reflect the light. The arrangements comprise two Gramme machines, giving light to four burners, each 4,000 candle-power. These machines will require about 10-horse-power to drive them, which will be found by steam or gas engines, both being provided for the new works.

The "Anglo-American Electric Light Company" are pushing ahead with their new works, and are obtaining considerable orders. They have recently applied the "Brush" light to a shipbuilding yard at Barrow-in-Furness, where 32 lights are used; the number is to be increased to 80. At Liverpool-street Station, the number of Brush lamps now employed is 31, and the installation is now said to be permanent. The same company have also applied their system to lighting with 16 lights Messrs. Bass & Co's. brewery at Burton, the number of lamps also in this case is to be extended. The Government are extending the use of the Brush light to another of the ironclads, and the authorities at Woolwich Arsenal have caused the carpenters' shops therein to be illuminated by the same system.

The progress of the light, however, cannot perhaps be better illustrated than by the fact that Messrs. Siemens Brothers have at the present time over 1,000 of their machines in use for electric lighting.

The telegraph service of Ceylon, hitherto worked by the Indian Government, has been taken over by the Government of the island.

Mr. R. Crowe of Liverpool communicates to the *British Journal of Photography* an account of some attempts to photograph a landscape by the aid of lightning-flashes. A gelatine plate, requiring by day an exposure of two seconds, was exposed from 10.15 p.m. to 10.45 p.m., during which time there were 120 brilliant flashes and about half as many minor ones. Most of these were in a horizontal direction, and five or six of them were imprinted on the negative. A perpendicular flash which struck a church-tower half a mile away was rendered with extraordinary sharpness and brilliancy. The surrounding objects, in spite of the long exposure, were but feebly impressed; whence Mr. Crowe argues that though the light of a flash of lightning is of a very actinic character, there still is not sufficient volume of light to illuminate a landscape or building to allow a successful photograph to be taken. Mr. Crowe further suggests that an attempt should be made to photograph, for scientific purposes of reference,

the varied forms assumed by lightning at different times and in different countries.

In a communication to the Göttingen Society of Sciences (*Nachr.*, No. 13), Herr Wöhler states that with aluminium *alone* and with very few elements, a galvanic battery may be formed of strength sufficient to deflect a magnetic needle strongly, decompose water, and raise a thin platinum wire to glow. In a cylindrical glass vessel holding very dilute muriatic acid or dilute soda lye, is placed a roll of sheet aluminium, and within this a porous cell containing concentrated nitric acid and a smaller roll of aluminium. A projecting piece of the metal from each roll is inserted in a circular cover of ebonite.—*Nature.*

On the occasion of the last meeting of the British Association at Swansea, in 1848, a paper was read by Mr. F. Wishaw "On the Telekouphon, or Speaking Telegraph." The apparatus is not an electrical arrangement, as some scientific papers have assumed; it is nothing more than the common speaking-tube, which appears to have been a novelty at the period when the communication was made to the Association.

By a presidential decree, dated July 22nd, the French Senate and Chamber of Deputies have approved the telegraphic convention concluded on the 14th March, 1880, between France, Spain, and Portugal, and the ratifications of this Act having been exchanged at Paris on the 21st July, 1880, its full and complete execution was agreed upon. The following are the most important articles of this convention:—Article 1: The tax on ordinary telegrams exchanged between France and Portugal is fixed at a uniform charge of 25 centimes per word. Article 2: This tax will be reduced to 20 centimes per word as soon as the French and Portuguese administrations are agreed that an increase of 20 per cent. in the traffic receipts between France and Portugal has taken place since the year 1878. Article 8: The preceding arrangements will be applicable to correspondence exchanged between Portugal on the one hand, and Algiers or Tunis on the other, by cables which land on French soil. But an additional tax of 10 centimes per word will be levied on submarine telegrams which are exclusively French.

Some experiments with the telephone have just been made on the cable belonging to the Cie. Française des Télégraphes de Paris à New York on the section between Brest and Penzance. Experiments were first made with the principal systems known, such as Bell, Phelps, Gower, Edison, &c., without a satisfactory result. A new system invented by a Dr. Herz was then tried. The voice was well carried across the Channel, and to a further distance of 300 kilometres inland. The important problem of the electric telephone on submarine cables seems to have been decided. At the same time another apparatus by the same inventor was tried. It is destined to play an important part in the telephone systems of large towns. Its object is to neutralise the induction which interferes so much with the telephone. The experiments have fully carried out the expectations of the inventor. These interesting trials were made at Brest in presence of the director of the French Cable, of the superintendent of the telegraph lines, of several Government officials, of engineers, and of scientific men.—*Journal des Débats.*

It has been noticed that during eruptions of Etna and Vesuvius, tests taken on the Marseilles-Barcelona, and Marseilles-Algiers cables are always very unsteady, positive earth currents being found to flow through the cables.

The City and Guilds of London Institute.—Every effort is being made by the promoters of this Institute to make the subjects taught as comprehensive as possible, and to make the instruction as thorough as possible. In the electrical branch Professor Ayrton is particularly active, and during the coming winter term the subjects of the electric light and electrical instrument making will be exhaustively treated. The syllabus of the electric light course is as follows:—

Heat produced by an electric current. Meaning of an electric current and of the direction of flow. Current is proportional to chemical decomposition. Meaning of resistance, resistance is proportional to square of the heat produced. Analogy and want of analogy of an electric current with a stream of water. Incandescence. Loss of heat by conduction, radiation, and convection. Vacuum lamps. Ohm's law. Electromotive force. Current and electromotive force necessary to maintain a given conductor at a given temperature. The electric arc. Opposing electromotive force set up in arc. Electric lamps, principles of the most important, Foucault's, Serrin's, Duboscq's, Siemens', &c. Electric candles, Werdermann's, Jablochkoff's. Combination of lighting by arc and by incandescence, Werdermann's, &c. Carbons, manufacture of, resistance of different kinds. Generators of electric currents, batteries, magneto and dynamo-machines, description and classification of the most important, Wilde's, Siemens', Gramme's, Lontin's, &c. Constant current, reverse current producers. Modes of measuring efficiency of current generators, actual results practically obtained. Measurement of light. Photometers. Proper employment of the electric light. Possibility of sub-division.

The Electrical Instrument Making course is very comprehensive, as will be seen from the following syllabus:—

Electro-Magnets.—Kind of iron to be used for the core, action of soft iron, hard iron, steel, iron filings, a bundle of iron wires, &c., coefficient of magnetic induction, coercitive force. Length and diameter of core proper to be used in different cases to give the strongest magnet. Covering wire with silk, cotton, &c. Winding on the wire, test for insulation of the layers. Effect of increasing the number of turns in a layer, or increasing the number of layers of wire. Connection between the strength of the electro-magnet and the current, saturation. Best shape to give to the coils, gauge of wire proper to be used in different cases. Should different gauges be used in the different layers of the coil of an electro-magnet? Value of high conductivity copper. Effect of using coils of insulated *iron* wire for an electro-magnet, &c.

Galvanometers.—Detectors are galvanoscopes only, Tangent-galvanometer, value of such a galvanometer. shape of coil, length and shape of magnetic needle. Hardening and tempering of steel for magnets. Connection between the current, deflection, number of turns of wire, and diameter of the coil. Error arising from the magnet not being short. Deflection for which this error is a minimum. Gaugain's device, conical coils, serious objection to Gaugain's plan arising from possible error due to eccentricity of needle. Helmholtz's double coil tangent-galvanometer. No necessity for the conical coils employed by instrument makers, shape proper to give to the channel of rectangular coils to diminish error arising from channel not being very small. Three coil tangent-galvanometer is one of the best practical forms. Sine galvanometer, no necessity for the coil being circular or the magnet short. More delicate than tangent-galvanometer, but can only be used for comparing constant currents. In any galvanometer the current proportional to the deflection of the latter is very small. Delicate reflecting galvano-

meters, best shape to give to coils, gauge of wire to be used in the different layers, how affected by the thickness of the silk, proper resistance to give to galvanometers. Tests to be employed during the winding of the wire, method of recording the length used. Astatic combinations, how practically made, measure of the astatic power. Neutralising the earth's force in other ways. Practical use of such methods. Suspending the magnets, torsion in the silk, cleaning and straining the silk fibre. Effect of putting iron in the galvanometer coils. Proper method of insulating the bobbins, and of insulating the terminals, defects of galvanometers as usually made. Dead beat galvanometers for measuring rapidly changing currents, strength of magnetic field, lightness of needle. Speaking galvanometers. Dead beat astatic combinations, construction of. Galvanometers for measuring rapidly reversing currents, such as are produced by dynamo-machines. Induction on the needle of currents in leading wires, how to avoid, &c.

Shunts.—Theory of, material to be used for wire in the construction of. Constant total current shunts. Shape to give the outside of a shunt box, &c.

Resistance Coils.—Resistance of a wire depends on its length, diameter, material, purity, hardness, temperature, age, &c. Choice of material and size of wire. Winding coils, insulation of, proper method to insulate ends. Testing coils, temperature corrections. Variation of temperature correction in different parts of the same coil of wire. Permanency of resisting power, annealing by time, artificial annealing of finished coils. Baking coils. Exterior of coil box, objection to highly polished ebonite, insulation of. Suitable coils to form a set. Plugs, revolving arms, slides. Thomson's and Varley's sliding coils, principle of, construction of circular forms. Standard coils, construction and testing of. Defect in standard coils as commonly made. Hermetically sealed coils. Method of constructing cheap accurate resistance coils, &c.

Condensers.—Construction of, materials employed. Necessity of drying the insulating compounds. Injury done by overheating a dielectric. Modes of purifying paraffin, shell-lac, &c. Capacity of a condenser depends on the area of the conducting coatings, the thickness, nature, and temperature of the dielectric. Practical methods of measuring the capacity and insulation of condensers. Adjustment of capacity. Effect of residual charge, how to diminish. Manufacture of condensers to be used with very high electromotive forces. Absolute condensers with calculable capacity, construction and practical use of.

Artificial cables, use and construction of. Tests of capacity, insulation of the dielectric, and resistance of the conductor. How to adjust each. Outside of condenser boxes, proper mode of making the terminals, &c.

The length of underground wires on the Brooks' system which has recently been in course of laying near the Nine Elms Station of the South Western Railway has been completed, and the tests of the same are very satisfactory.

Permission has been conceded by the Government of Colombia to the Central and South American Cable Company to lay a cable on the west coast of Panama, connecting it with the Central American coast, and thence with other lines to Mexico and the United States. This permission does not imply an exclusive privilege.

A vast telegraph scheme, says the *Montreal Witness*, which in this age it would be folly to decry as impracticable, is mooted, Mr. F. N. Gisborne, superintendent of the Dominion Telegraph Signal Service, being mentioned as the author. It is no less than to connect America with Asia and Europe, under British auspices, by a system of which a line from the Atlantic to the Pacific through Canada is to form a part. To effect this portion of the scheme, a line from Edmonton, Northwest Territory, to Cache Creek, British Columbia, remains to be built. A cable from Vancouver Island to the Aleutian Islands will constitute the major portion of the connection with Asia, a few minor links remaining to complete an electric girdle around the earth, with Britain's hands on the buckle. A cable from Japan to Australia, by way of the Kurile Islands, is a supplemental part of Mr. Gisborne's scheme, of great moment to imperial interests. The consummation of the entire project would give the Imperial Government facilities for instantaneous communication with the principal possessions of the Empire, which would be a boon of incalculable value to the power that stands unique in the extent and remoteness from herself and from each other of her colonies.

In no department of the W. U. Telegraph Company has the volume of business so suddenly and enormously increased as in the cable department. Cablegrams, at one time counted by hundreds, are now registered up in the thousands. This unprecedented increase of business is, of course, due to the late large reductions in cable rates. Not only have messages poured in vast numbers, but they have been much lengthened. Many customers write long letters daily to their European houses and transmit them over the cables. It is wonderful to observe the number of office messages received and answered daily at the Cable Department, at 197, Broadway, concerning cablegrams to and from all parts of the globe. In this, as well as all other business relations, New York City is the grand clearing house for the whole Western continent.—*Magnet.*

The Bell Telephone Company of Canada has just closed with the Montreal Telegraph Company for the purchase of the latter company's telephone business and plant. The price, 75,000 dols., is to be paid 50,000 dols. in cash and 25,000 dols. in stock. This gives the Bell Company complete control of all the telephone business of Canada except Toronto, and it is expected that the negotiations for the purchase of the Toronto Company will be completed in a few days. The price is said to be 22,500 dols. in cash and stock. It is understood that Mr. H. Neilson is to remain as manager of the Toronto Company, as at present.—*Operator.*

In a paper on the earth as a conductor of electricity, Prof. Trowbridge, of Harvard, arrives at these conclusions: 1. Disturbances in telephonic circuits usually attributed to effects of induction are in general due to contiguous grounds of battery circuits. A return wire is the only way to obviate these disturbances. 2. The well-defined equipotential surfaces in the neighbourhood of battery grounds shows the theoretical possibility of telegraphing across large bodies of water without employment of a cable; and leads us to extend greatly the practical limit set by Steinheil. 3. Earth circuits have an intermittent character, with periods of maxima and minima, which may occur several times a minute during the entire day. This intermittent character is seldom absent.—*Magnet.*

An exhibition of electric light and other apparatus is announced for September 27th at the Alexandra Palace. Manufacturers, contractors, and others who are interested we refer to advertisement on page 10.

Electric light companies and others, who intend estimating for lighting several of the City thoroughfares, are required to send in their tenders by two o'clock on the 10th September, as will be seen by advertisement, page 10.

New Patents—1880.

3219. "An improved method and apparatus for obviating the effects of extraneous electrical disturbances on telephonic lines." J. Imray. (Communicated by Dr. C. Herz.) Dated August 6.

3310. "Improvements in insulating telegraph conductors, and in the mode of, and in machinery for, manufacturing telegraph conductors, the improved machinery being also applicable for other purposes." E. T. Truman. Dated August 14.

3231. "Telephonic apparatus." H. H. Lake. (Communicated by L. Maiches.) Dated August 7.

3324. "Dynamo-electric, magneto-electric, and electro-dynamic machines." C. G. Gumpel. Dated August 16.

3373. "Heliostats, or instruments for signalling by sun flashes." T. Anderson. Dated August 19.

3420. "Electro acoustic apparatus, called 'Phonophore.'" F. R. Von Wreden. Dated August 23.

3424. "Improvements in electric conductors, and in a compound or compounds for preventing the deterioration of rubber insulators." G. Barker. (Communicated by W. W. Jacques.) Dated August 24.

3438. "Mode and means of and fastener for securing telegraph wires to their insulators." A. E. Gilbert. Dated August 25.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

5045. "Inclinatoriums or dipping azimuth compasses." J. Imray. (A communication from Joseph Peichl, of Trieste.) Relates to a construction of compass which serves independently of any extraneous sighting beyond the ship, firstly, to ascertain the coefficient of deviation or the total deviation of a compass; secondly, to ascertain small amounts of the total deviations in the course steered in ships' azimuths, deviating at most 30° from such course; and, thirdly, to enable the compensation of the compass in analogous ships' azimuths to be rectified. A double needle mounted as a dipping needle with pinion has its steel or other axis carried in agate or other bearings in a casing consisting of an upper and a lower part. The lower part has fixed or formed round its outer surface, at about the level of the axis of the dipping needle, a horizontal circular disc suspended by diametrically opposite axes in bearings provided with anti-friction rollers on the gimbal ring. The upper part of the casing is removable, forming a cover. The axes of the gimbal rings are carried in a guide ring which can turn concentrically with the vertical axis of the needle, and which for this purpose rests in a circular seat in a fixed plate, and is provided with adjusting screws and an azimuth index. The claims are, first, for an improved construction of control compass; secondly, the use of an inclination needle with prismatic or double knife edge axis within a casing provided with gimbal ring suspension; thirdly, the use of the inclination needle provided with one or with two mirrors, within the needle casing provided with gimbal ring suspension, as also the use of a scale within the gimbal suspension; and fourthly, the use of induction bars or of one or more of them, whereby the changes of inclination of the needle due to alterations of the course are accelerated, thus increasing the sensitiveness of the apparatus.

5078. "Electrical signal apparatus." W. R. Lake. (A communication from F. Blake, Junr., of Weston, U.S.A.) Dated December 11. 6d. Relates to electric signalling apparatus, and comprises the employment of a pendulum hung as the armature of an electro-magnet in connection with a device for automatically making and breaking the circuit to which the electro-magnet belongs at intervals corresponding to the rate of vibration of the pendulum. It also comprises the employment of a series of pendulums of different lengths, in connection with a series of electro-magnets in a common circuit, and a suitable device for automatically making and breaking the circuit at intervals corresponding to the rate of vibration of either pendulum. Also it comprises the employment of two pendulums vibrating in equal times, one hung as the armature of an electro-magnet, and the other operating a circuit closer to make and break the circuit containing the electro-magnet at each vibration.

5085. "Dynamo-electric machines and electro-motive engines." W. L. Wise. (Communicated by Emil Bürgin of Basel.) Dated December 11. 8d. This invention is designed to produce compact and simple machines for the production of continuous or of alternative currents of electricity, and consists in a novel construction of the generating cylinder, in a novel combination of a commutator with such cylinder, and in certain details of construction.

5114. "Facilitating telephonic communication." W. R. Lake. (Communicated by M. D. Connolly and others.) Dated December 13. 8d. Has for its object to provide an "*automatic* telephone exchange." By the employment of electricity and electro-magnetism all the operations of the central office are rendered automatic. Any member may communicate with any other member whose line is unoccupied; at the same time he can isolate his own and the line he desires to communicate with from all others. He is enabled to signal the member to be communicated with and receive the answering signal, and while these two are using their lines all the other members can be using their lines two and two without any interference of one line with another. Each station comprises the usual battery, a telephone, a call bell, a reversing key, a compound switch, and a dial instrument. The latter produces breaks in the electric current, the number of said breaks being indicated on the dial by a pointer, and causes the central office mechanism pertaining to the given line to operate and establish the connection of the two lines. Then the current is reversed and brings into action mechanism at the central station which isolates the connected lines and rings the bell at the station to be called. At the station this signalling main is then switched to the bell. The person at the signalled station now shunts his battery into the main line and rings the bell at the signalling station. Both persons now switch to their respective telephones, cutting out the bells, and if necessary, the batteries from main line, when conversation may be carried on. When they cease talking the two parties restore the devices to their normal condition so that other persons may communicate with either.

5119. "Electric telegraphs." Sir James Anderson, Knt., and Francis Strudwick Harwood. Dated December 13. 2d. Has for its object to increase the speed of signalling through submarine telegraph cables and covered land lines when working "duplex," although part of the invention may also be used to facilitate "simplex" working. The object is attained when

working "duplex" by applying that pole of the battery required for the signal, to be made through a suitable key direct to the cable itself without the intervention of any resistance coils. Secondly, by providing for perfectly neutralising or "wiping out" the effects of induction in the cable by applying to it after each signal an induced current of the opposite sign, graduated, to be of exactly the same potential and duration as the induced or "return" current that is set up in the cable by the application of the currents of the signalling battery. Thirdly, by avoiding the use between the signalling battery and the cable in sending, or between the cable and the receiving instrument in receiving, of any resistance coils in a position to cause retardation to the signals by passing the signalling currents through them. *(Provisional only.)*

5126. "Electric signalling apparatus for use in the loading and unloading of ships." W. WHITE. Dated December 15. 2d. Comprises an electric alarm bell of ordinary construction and recording arrangement, which is fitted in a wooden box in the engine room, or other convenient situation near the engine man or other attendant, and is connected by separate insulated wires with an improved construction of communicator or contact-making apparatus to be held in the hand of the person in charge of the loading operations. *(Provisional only.)*

5127. "Electric lamps." T. A. EDISON. Dated December 15. 6d. Relates to an improvement in the process of manufacturing the carbon filament used in the patenteed glass bulb lamp, from which the atmosphere has been as nearly as possible removed. Narrow strips of "Bristol board" preferably in the form of an elliptical bow or an arc of a circle, the ends of the strip being by preference wider than the other portions. Several of these are laid in a mould and a light weight placed over them, and the mould is then raised very gradually to a temperature of about 600° Fahr. The mould is then placed in a furnace and heated almost to a white heat, and afterwards removed and allowed to cool gradually.

5149. "Telephones." JOHN IMRAY. (A communication by J. F. Bailey, U.S.A.) Dated December 16. 6d. Relates to telephones of the kind in which a current from a battery in passing through the transmitter undergoes variations resulting from action on an imperfect conductor, such as carbon, by a membrane or diaphragm caused to vibrate by sound impulses.

5156. "Electric light regulators." S. PITT. (A communication from C. E. Scribner, of Chicago.) Dated December 16. 8d. Describes an arc lamp. One of the carbon holders, say the upper, is attached to a rod or metallic stem which is held loosely in a spring or friction clip, this clip being carried upon the armature of an electro-magnet which is capable of working up and down a distance about equal to that by which the carbons are separated when the light is properly displayed. This electro-magnet is in the main circuit, and so soon as a current passes, the armature is attracted, and it raises with it the rod, the carbon holder, and carbon, for there is a special device to insure that the armature shall in its upward movement carry the rod with it. Immediately that the arc ceases the armature falls away from the magnet and the carbon points are brought into contact, re-establishing the circuit. The automatic feed to compensate for the consumption of the carbon while the lamp is burning is effected by means of another electro-magnet and armature. The coils of this magnet are in a short circuit or shunt by which the electric arc is shunted, hence, as the resistance of the arc increases from the burning away of the carbon, the amount of current passing in the shunt circuit becomes gradually greater and the armature more strongly attracted. This armature is suspended by springs, and its movement towards the poles of the magnet takes place in a downward direction.

5157. "Magneto-electric machines and electric light apparatus." H. F. JOEL. Dated December 16. 10d. Consists essentially of a new, simple, and convenient combination of inducing electro-magnets or permanent magnets with induced electro-magnetic armatures or coils, whereby great surface is brought into magnetic action, and a special and additional induction current is produced by the reaction of the aforesaid armature coils upon the wire of the inducing electro-magnets or upon separate coils, the armature coils thus becoming in their turn inducing magnets. Also of special arrangements whereby constant currents are produced without a commutator and also of a peculiar construction and arrangement of inducing electro-magnets. Likewise of an arrangement whereby the retention of magnetism in the induced core is made to automatically regulate, by means of a commutator, the change of direction of the currents. An arc lamp is also described.

5167. "Safety alarm signalling apparatus for steam boilers." W. WHITE. Dated December 17. 6d. In addition to the usual indicating hand of a steam pressure gauge, there is fitted a stationary pointer which may be moved round by hand and set to any desired degree of pressure. When the steam pressure causes the moving hand to travel round to the stationary pointer, electric contact is made and a bell is rung. A similar arrangement may also be used as a water level indicator.

5175. "Insulating mariners' compasses." A. W. LOVELL REDDIE. (A communication from J. B. Siccardi, of Varazze.) Dated December 17. 2d. To effect insulation a box is provided, say about 28 inches square by 20 inches high, made of wood or other non-conducting material; this box is constructed at the top with a well in the centre of sufficient depth to contain the compass which is to be insulated, the top of which, when fitted in the well, will be about flush with the top of the box. The interior of the box is then filled with sea sand of moderate coarseness which closely surrounds the shallow well containing the compass on all its sides and bottom. *(Provisional only.)*

5177. "Lighting gas by electricity." JAMES MACKENZIE. Dated December 17. 6d. Consists of an arrangement for starting and stopping clockwork, which actuates a switch by means of the same battery current which produces a secondary current, and so lights the gas, thus admitting of the induction coil and the switch being fixed close to the chandelier or other series or groups of gas-burners to be lighted.

5219. "Galvanic batteries." THEOPHILUS COAD. Dated December 20. 6d. The usual positive and negative electrodes are employed and any suitable fluids, but a cock is applied to each of the outer cells for drawing off the fluid when required; or the cells may be connected by suitable pipes and stop-cocks so that they may all be filled or emptied from one cell.

5319. "Telephonic exchange system." ERNEST DE PASS. Dated December 30. 2d. Proposes to overcome objections to the present system by using two wires and circuits, one for connection or disconnection calls or signals, and the other for private communication between subscribers. A system without employing two wires and circuits is also described. *(Provisional only.)*

THE following letter has been published by the managing director of the Anglo-American Telegraph Company:

Sir,—I beg to inform you that an additional line of telegraphic communication across the Atlantic has just been completed by the laying down of a new cable between this Company's stations at Heart's Content, Newfoundland, and Valentia, Ireland. The work has been most successfully carried out by the Telegraph Construction and Maintenance Company without a hitch having occurred during the whole operation. The ships employed have been the *Scotia*, ss., and the *Seine*, ss., the expedition having been under the command of Captain Halpin; the electrical arrangements under the charge of Mr. J. C. Laws, on behalf of the Construction Company, and of Mr. C. Hockin, of the firm of Clark, Ford, and Co., on behalf of the Anglo-American Company. This is the seventh cable laid by the Telegraph Construction and Maintenance Company across the Atlantic for the Anglo-American Company and their predecessor, four of which are now in working order. The expedition started from Heart's Content on the 10th inst., and the final splice was completed off the coast of Ireland on the 21st inst., a period of 12 days, being the quickest Atlantic cable passage on record.—I am, Sir, your obedient servant,

H. WEAVER, Managing Director.

Anglo-American Telegraph Company (Limited),
26, Old Broad-street, London, E.C., August 23.

WE are informed that Mr. Edward Cross has resigned his seat on the board of the Western and Brazilian Telegraph Company. It is also announced that Mr. Sam. Mendel has resigned his seat at the board.

ACCORDING to the *Paris Bourse* a joint purse arrangement has been made between the Anglo-American and Direct Cable Companies with the Pouyer-Quertier Cable, under which the latter obtains 16 per cent. on the common receipts. These terms have not been easily obtained, and may be considered favourable. This announcement occasioned a considerable rise in the price of Atlantic Cable shares, which, however, drooped away to some extent on a statement being made that the negotiation had at the last moment failed. Since then another paragraph on the subject has appeared in the *Paris Bourse*, it runs as follows:—"The meeting of the delegates with M. Pouyer-Quertier for the purpose of exchanging the signatures of the contract, which on every point has been agreed to by all the parties concerned, has taken place. A technical question, however, turned up at the last moment, and the parties decided to postpone the signature until it was solved. This is the cause of the delay, and we may add that it is almost tantamount to a mere formality."

The following are the final quotations of telegraphs for the 31st August.—Anglo-American Limited, 66-66½; Ditto, Preferred, 97-97½; Ditto, Deferred, 36¾-37¼; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9-9¼; Cuba, Limited, 9½-9¾; Cuba, Limited, 10 per cent. Preference, 16½-17; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11½-12; Direct United States Cable, Limited, 1877, 12½-12¾; Scrip of Debentures, 103-105; Eastern, Limited, 9¾-10; Eastern 6 per cent. Preference, 12¾-13; Eastern, 6 per cent. Debentures, repayable October, 1883, 106-108; Eastern 5 per cent. Debentures, repayable August, 1887, 103-106; Eastern, 5 per cent., repayable Aug., 1899, 103-106; Eastern Extension, Australasian and China, Limited, 9⅞-10⅛; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 103-105; Ditto, registered, repayable 1900, 103-106; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 102-104; Ditto, ditto, to bearer, 101-103; German Union Telegraph and Trust, 9-9½; Globe Télegraph and Trust, Limited, 6¾-7; Globe, 6 per cent. Preference, 12¼-12½; Grea: Northern, 9½-9¾; Indo-European, Limited, 24½-25½; London Platino-Brazilian, Limited, 4¾-5¼; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 9½-10½; Submarine, 240-250; Submarine Scrip, 2¼-2½; West Coast of America, Limited, 2¼-2½; West India and Panama, Limited, 1½-1¾; Ditto, 6 per cent. First Preference, 7¾-8; Ditto, ditto, Second Preference, 7-7½; Western and Brazilian, Limited, 7-7¼; Ditto, 6 per cent. Debentures "A," ——; Ditto, ditto, ditto, "B," 96-99; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 34½-35; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3⅛-3⅜; India Rubber Company 15¾-16¼; Ditto 6 per cent. Debenture, 105-107.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
July, 1880 ...	*	a 12,045	2,800	1,423	*	45,279	32,194	23,560	... ...	... ...	... ...	a 9,929	3,701
July, 1879 ...	49,320	16,299	2,932	913	16,440	35,789	23,411	20,421	... ...	11,733	... ...	10,697	4,877
Increase	... ...	... ...	... ...	510	... ...	9,490	8,783	30.39	... ...	... ...	... ...	... ...	... ...
Decrease	... ..	4,254	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	168	1,176

* Publi..tion of receipts temporarily suspended. a Five weeks.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

Vol. VIII.—No. 183.

PATENTS.

The chances of a reform in the Patent Laws being thoroughly discussed in Parliament seem to grow less and less each succeeding session, and although considerable pressure is no doubt brought to bear upon the authorities with whom the question of reform rests, the matter has practically made no progress at all. The general tendency of the age is to cheapen every convenience to the public which is carried on under Government management. The Post has long been reformed in this respect; some forty years have passed since the postage of a letter was reduced from one shilling to one penny. The Telegraph is almost immediately to be reformed in this direction, but the tax on Patents, which has been a clog to inventors in this country, seems as far as ever from being reduced to reasonable dimensions. At the present time a man who so far loses control over himself as to commit an assault upon one of his fellow-creatures, is fined a few shillings for the deed, whereas, any one who is audacious enough to protect the conception of his brain is fined from £50 to £200 for leave to do so. Inventors know full well that any invention of value, if brought to public notice without being protected, is practically money put into other people's pockets and none into their own, and being in very many cases unwilling or unable to command such a sum as £50—for a patent is of little or no value unless valid for at least three years—they prefer to keep their ideas to themselves.

The arguments against the patent laws, as they at present exist, are so numerous, and have been brought forward so often, that but little more can be said against them. What is wanted is a continual agitation and pressure brought to bear until something is done. Statistics of patents taken out in the United States bear eloquent testimony to the value of a patent with low fees. The inventive genius of the American is proverbial, and although it cannot be said for certain that this is due to the satisfactory state of the patent law in the United States, yet it is a very general opinion that it has much to do with it. It would almost appear that the object of the patent laws in England is to discourage invention as much as possible. The laws are certainly not such as to encourage it.

At the present day, when foreign competition is so keen in every branch of practical science, it is of the highest importance to the welfare of the nation that every encouragement should be given to invention. The subject is, no doubt, a difficult one to deal with properly, and cannot be settled off-hand, as many imagine, but it is none the less urgent on that account.

THE BRITISH ASSOCIATION MEETING.

(Continued from page 289.)

At each stage of the process there must be a considerable absorption of heat to produce the change of state, and our supply of heat is limited in the electric arc because of the dissociation of the conductors, and more limited still in quantity in the electric spark or in the discharge through a vacuum tube, also we should expect a recombination of the dissociated substances immediately after they have been first dissociated. Hence it seems easier to suppose that at temperatures which we can command on the earth, the dissociation of molecules by the arc or the spark is accompanied by the formation of new compounds, in the formation of which heat and light, and especially chemical vibrations, would be again given out, giving rise to new spectra, rather than to suppose that we can reach the temperature necessary for successive stages of dissociation.

To the lines C, F, the line near G and *h* belonging to hydrogen, which have a certain rhythmical character, Mr. Lockyer adds D_3 and Kirchoff's line "1474," regarding "1474" (wave-length) as belonging to the coolest or most complex form, and rising to F, which is again subdivided into C and G, using the spark without a condenser, which again gives *h* with the spark and condenser, which is again split up and gives D_3, a more simple line than *h*, in the chromosphere. Professors Liveing and Dewar, on the other hand, trace a rhythmical character or ratio between three of the brightest lines of the chromosphere, two of which are lines "1474" and "f" of Lorenzoni, similar to the character of C, F, and *h* of hydrogen, and also trace a similar relation between the chromospheric line D_3 and "1474" to the ratio of the wave-lengths of F and the line near G. They infer the probability that these four lines are due to the same at present unknown substance as had been suggested by Young with regard to two of them.

The harmony of this arrangement is somewhat disturbed by the fact that D_3 lies on the wrong side of "1474" to correspond with the line near G of the hydrogen spectrum.

If we inquire what our sun and the stars have to say to these changes of spectra of the same substance at different temperatures, Dr. Huggins gives us the answer.

In the stars which gives a very *white* light, such as Sirius or *a* Lyræ, we have the lines G and *h* of hydrogen and also H^1, which has been shown by Dr. Vogel to be coincident with a line of hydrogen; but the K line of calcium is weak in *a* Lyræ, and does not appear in Sirius. In passing from the white or hottest stars to the yellow stars like our sun, the typical lines diminish in breadth and are better defined, and K becomes stronger relatively to H, and other lines appear. In Arcturus we have a star which is probably cooler than our sun, and in it the line K is stronger in relation to H than it is in the solar spectrum, both being very

strong compared with their state in the solar spectrum.

Professors Liveing and Dewar find that K is more easily reversed than H in the electric arc, which agrees with the idea that this line is produced at a lower temperature than H.

Besides the absence or weakness of K, the white stars have twelve strong lines winged at the edges, in which there are three of hydrogen, viz., G, *h*, and H, and the remaining nine form a group which are so related to one another that Dr. Huggins concludes they probably belong to one substance. Three of these lines are said by Dr. Vogel to be lines of hydrogen.

Liveing and Dewar have made considerable progress in determining the conditions and the order of reversal of the spectral lines of metallic vapours. They have adopted methods which allow them to observe through greater thicknesses of vapour than previous observers have generally employed. For lower temperatures tubes of iron or other material placed vertically in a furnace were used, and the hot bottom of the tube was the source of light, the absorption being produced by vapours of metals dropped into the hot tube and filling it to a greater or less height. By this means many of the more volatile metals, such as sodium, thallium, iridium, cæsium, and rubidium, magnesium, lithium, barium, strontium, and calcium, each gave a reversal of its most characteristic line or pair of lines, *i.e.*, the red line of lithium, the voilet lines of rubidium and calcium, the blue line of strontium, the sharp green line of barium (5535), and no other lines which can certainly be ascribed to those metals in the elementary state.

For higher temperatures tubes bored out in blocks of lime or of gas carbon, and heated by the electric arc, were used. By keeping up a a supply of metal and in some cases assisting its volatilisation by the admixture of a more volatile metal, such as magnesium, and its reduction by some easily oxidisable metal, such as aluminium, or by a current of coal gas or hydrogen, they succeeded in maintaining a stream of vapour through the tube so as to reverse a great many lines. In this way the greater part of the bright lines of the metals of the alkalies and alkaline earths were reversed, as well as some of the strongest lines of manganese, aluminium, zinc, cadmium, silver, copper, bismuth, and the two characteristic lines of iridium and of gallium. By passing an iron wire into the arc through a perforated carbon electrode they succeeded in obtaining the reversal of many of the lines of iron. In observing bright line spectra they have found that the arc produced by a De Meritens machine arranged for high tension gives, in an atmosphere of hydrogen, the lines C and F, although the arc of a powerful Siemens machine does not bring them out, and they have observed many metallic lines in the arc which had not been previously noticed. The temperature obtained by the De Meritens machine is thus higher than that obtained in the Siemens machine.

From observations on weighed quantities of sodium, alone and as an amalgam, introduced into a hot bottle of platinum filled with nitrogen, of which the pressure was varied by an air-pump, they conclude that the width of the sodium lines depends rather on the thickness and temperature of the vapour than upon the whole quantity of sodium present. Very minute quantities diffused into the cool part of the tube give a broad diffuse absorption, while a thin layer of compressed vapour in the hot part of the tube gives only narrow absorption lines. Professors Liveing and Dewar have observed the reversal of some of the well-known bands of the oxides and chlorides of the alkaline earth metals. The lines produced by magnesium in hydrogen form a rhythmical series extending all across the well-known B group, having a close resemblance in general character to the series of lines produced by an electric discharge in a vacuum tube of olefiant gas.

The series appears at all temperatures except when a large condenser is employed along with the induction coil, provided hydrogen is present as well as magnesium, while they disappear when hydrogen is excluded, and never appear in dry nitrogen or carbonic oxide.

From their experiments on carbon spectra they conclude with Angstrom and Thalèn that certain of the so-called "carbon bands" are due to some compound of carbon with hydrogen, probably acetylene, and that certain others are due to a compound of carbon with nitrogen, probably cyanogen.

They describe some ultra-violet bands: one of them coincides with the shaded band P of the solar spectrum which accompanies the other violet bands in the flame of cyanogen as well as in the arc and spark between carbon electrodes in the nitrogen. All the bands which they ascribe to a compound of carbon and nitrogen disappear when the discharge is fallen in a non-nitrogenous gas, and they reappear on the introduction of a minute quantity of nitrogen.

They appear in the flame of hydrocyanic acid, or of cyanogen, even when cooled down as much as possible as shown by Watts, or when raised to the highest temperature by burning the cyanogen in nitric oxide; but no flames appear to give these bands unless the burning substance contains nitrogen already united with carbon. As the views of Mr. Lockyer with regard to the multiple spectra of carbon have very recently appeared in the pages of *Nature*, I need only say that these spectra are looked upon as supporting his theory that the different flutings are truly due to carbon, and that they represent the vibrations of different molecular groupings. The matter is one of very great interest as regards the spectra of comets, for the bands ascribed to acetylene occur in the spectra of comets without the bands of nitrogen, showing that either hydro-carbons must exist ready formed in the comets, in which case the temperature need not exceed that of an ordinary flame, or else nitrogen must be absent, as the temperature which would produce acetylene from its elements would also produce cyanogen, if nitrogen were present.

Quite recently, Professors Liveing and Dewar have, simultaneously with Dr. Huggins, described an ultra-violet emission spectrum of water, and have given maps of this spectrum. It is not a little remarkable that by independent methods these observers should have deduced the same numbers for the wave-lengths of the two strong lines at the most refrangible end of this spectrum.

Great atention has been paid by M. Mascart and by M. Cornu to the ultra-violet end of the solar spectrum. M. Mascart was able to fix lines in the solar spectrum as far as the line R (3179), but was stopped by the faintness of the photographic impression. Professor Cornu has extended the spectrum still farther to the limit (2948), beyond which no further effect is produced, owing to complete absorption by the earth's atmosphere. A quartz-reflecting prism was used instead of a heliostat. The curvature of the quartz lens was calculated so as to give minimum aberration for a large field of view. The Iceland spar prism was very carefully cut. A lens of quartz was employed to focus the sun on the slit. Having photographed as far as possible by direct solar light, Professor Cornu compared the solar spectrum directly by means of a fluorescent eye-piece with the spectrum of iron, and then obtained, by photographing, the exact positions of the iron lines which were coincident with observed lines in the solar spectrum. M. Cornu states that the dark absorption lines in the sun and the bright iron lines of the same refrangibility are of the same relative importance or intensity in their

spectra, indicating the equality between the emissive and the absorbing powers of metallic vapours; and he thinks that we may get by the comparison of bright spectra with the sun some rough approximation to the quantity of metallic vapours present in the absorption layers of the sun's atmosphere. He draws attention to the abundance of the magnetic metals—iron, nickel, and magnesium—and to the fact that these substances form the composition of most meteorites. M. Cornu has studied the extent of the ultra-violet end of the spectrum, and finds that it is more extended in winter than in summer, and that, at different elevations, the gain in length of the spectrum for increase of elevation is very slow on account of atmospheric absorption, so that we cannot hope greatly to extend the spectrum by taking elevated observing stations. The limit of the solar spectrum is reached very rapidly, and the spectrum is sharply and completely cut off at about the line U (wave-length 2948). From photographs taken at Viesch, in the valley of the Rhone and at the Riffelberg, 1910 metres above it, M. Cornu finds the limits to be at wave-lengths 2950 and 2930 respectively.

In the actual absorption of bright line spectra by the earth's atmosphere, M. Cornu observed among others three bright lines of aluminium, which M. Soret calls 30, 31, and 32 (wave-lengths about 1988, 1930, and 1860), and he found that 32 could not be seen at the distance of 6 metres; but on using a collimator, and reducing the distance to 1½ metres, the line 32 became visible, notwithstanding the absorption of the extra lens; at 1 metre line 32 was brighter than 31, and at a quarter of a metre 32 was brighter than either 30 or 31. With a tube 4 metres in length between the collimator and prism ray 32 is not seen; but when the tube is exhausted, ray 31 gains in intensity and 32 comes into view, and gradually gets brighter than 31, whilst 30 changes very little during the exhaustion. With the same tube he found no appreciable difference between the absorption by air very carefully dried and by moist air, and concludes that this absorption is not due to the vapour of water, and it follows the law of pressure of the atmosphere which shows it to be due to the whole mass or thickness of the air. Also, M. Soret has shown that water acts very differently on the two ends of the spectrum, distilled water being perfectly transparent for the most refrangible rays, since a column of water of 116 c.m. allowed the ray 2060 in the spectrum of zinc to pass through; on the other hand, water is so opaque to the ultra-red rays that a length of 1 c.m. of it reduces the heat spectra of metals to half their length and one quarter of their intensity.

In concluding my address, I wish to draw attention to some of those magnetic changes which are due to the action of the sun, and which are probably brought about by means of the ether which brings to us his radiant heat and light.

In his discussion of the magnetic effects observed on the earth's surface, General Sabine has shown the existence of diurnal variations due to the magnetic action of the sun; also the magnetic disturbances, aurora and earth currents, which are now again beginning to be large and frequent, have been set down to disturbances in the sun.

Although iron, when raised to incandescence, has its power of attracting a magnet very greatly diminished, we have no proof that it has absolutely no magnetic power left, and with a slight magnetic action the quantity of iron in the sun would be sufficient to account for the diurnal variations of the magnetic needle. During the last few weeks I have been engaged in examining the declination curves for the month of March, 1879, which have been kindly lent to the Kew Committee by the Directors of the Observatories of St. Petersburg, Vienna, Lisbon, Coimbra, and Stonyhurst. Other curves are on their way from more distant stations, but have not yet been examined. On comparing them with the Kew curves for the same period, I find the most remarkable coincidences between the curves from those widely distant stations. It was previously known that there was a similarity between disturbances at different stations, and in one or two cases a comparison between Lisbon and Kew had been made many years ago by Senor Capello and Professor Balfour Stewart, but the actual photographic magnetic records from several stations have never been previously collected, and so the opportunity for such comparisons had not arisen. Allow me, in concluding my address, to draw attention to a few of the more prominent features of these comparisons which I have made. On placing the declination curves over one another, I find that in many cases there is absolute agreement between them, so that the rate of change of magnetic disturbances at widely distant stations like Kew, Vienna, and St. Petersburg is precisely the same; also similar disturbances take place at different stations at the same absolute time. It may be stated generally, for large as well as small disturbances, that the east and west deflections of the declination needle take place at the same time and are of the same character at these widely distant stations.

There are exceptions to this law. Some disturbances occur at one or two stations and are not perceived at another station. Many instances occur where, up to a certain point of time, the disturbances at all the stations are precisely alike, but suddenly at one or two stations the disturbance changes its character: for instance, on comparing Kew and St. Petersburg, we get perfect similarity followed by deflections of the needle, opposite ways at the same instant, and in some such cases the maxima in opposite directions are reached at the same instant, showing that the opposite deflections are produced by the same cause, and that the immediate cause or medium of disturbance in such a case is not far off; probably it is some change of direction or intensity of the earth's magnetism arising from solar action upon it.

Generally, after an hour or two, these differences in the effects of the disturbance vanish, and the disturbances again become alike and simultaneous. In such cases of difference, if the curve tracing of the horizontal or the vertical force be examined, it is generally found that, at the very same instant of absolute time, with the beginning of these opposite movements there was an increase or a diminution in the horizontal force, and that the horizontal force continues to change as long as there is any difference in the character of the declination curves. It is clear, then, from these effects that the cause or causes of magnetic disturbances are in general far distant from the earth's surface, even when those disturbances are large; but that not unfrequently these causes act on magnetic matter nearer to the surface of the earth, and therefore at times between two places of observation, and nearer to one than another, thus producing opposite effects on the declination needle at those places; in in such cases the differences are probably due to changes in the earth's magnetic force. Now, if we imagine the masses of iron, nickel, and magnesium in the sun to retain even a slight degree of magnetic power in their gaseous state—and we know from the researches of Faraday that gases are some of them magnetic—we have a sufficient cause for all our terrestrial magnetic changes, for we know that these masses of metal are ever boiling up from the lower and hotter levels of the sun's atmosphere to the cooler upper regions, where they must again form clouds to throw out their light and heat, and to absorb the light and heat coming from the

hotter lower regions; then they become condensed and are drawn again back towards the body of the sun, so forming those remarkable dark spaces or sun spots by their downrush towards the lower levels.

In these vast changes, which we know from the science of energy must be taking place, but of the vastness of which we can have no conception, we have abundant cause for these magnetic changes which we observe at the same instant at distant points on the surface of the earth, and the same cause acting by induction on the magnetic matter within and on the earth may well produce changes in the magnitude or in the direction of its total magnetic force. These magnetic changes on the earth will influence the declination needles at different places, and will cause them to be deflected; the direction of the deflection must depend on the situation of the earth's magnetic axis or the direction of its motion with regard to the stations where the observations are made. Thus both directly and indirectly we may find in the sun not only the cause of diurnal magnetic variations, but also the cause of these remarkable magnetic changes and disturbances over the surface of the earth.

IMPROVED HELIOGRAPH OR SUN SIGNAL.

By TEMPEST ANDERSON, M.D., B.Sc.

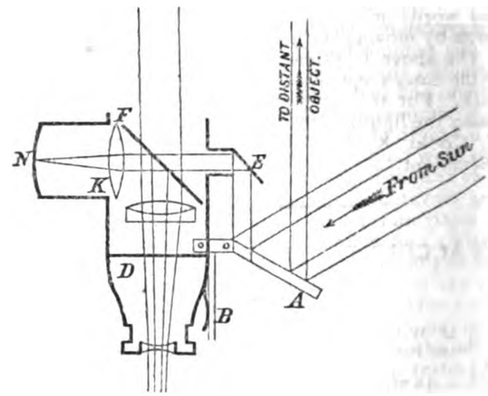
(Read before the British Association, Aug., 1880.)

THE author claims to have contrived a heliograph, or sun telegraph, by which the rays of the sun can be directed on any given point with greater ease and certainty than by those at present in use.

When the sun's rays are reflected at a small plane surface considered as a point, the reflected rays form a cone, whose vertex is at the reflector and whose vertical angle is equal to that subtended by the sun. Adding to the size of the mirror adds other cones of light, whose bounding rays are parallel with those proceeding from other points of the mirror, and only distant from them the same distance as the points on the mirror from which they are reflected. Hence increasing the size of the mirror only adds to the field to which the sun's rays are reflected a diameter equal to the diameter of the mirror, and this at any distance at which the sun-signal would be used is quite inappreciable. Adding to the size of the mirror adds to the number of rays sent to each point, and hence to the brightness of the visible flash, but not to the area over which it is visible.

By the author's plan, an ordinary field-glass is used to find the position of the object to be signalled to, and to it is attached, in the position of the ordinary sunshade, a small and light apparatus, so arranged that when the mirror is turned to direct the cone of rays to any object within the field of view of the glass, an image of the sun appears in the field, at the same time as the image of the distant object, and magnified to the same degree, and the part of the field covered by this image is exactly that part to which the rays are reflected, and at which some part of the sun's disc is visible in the mirror.

A perfectly plane silvered mirror, A, takes up the rays of the sun, and when in proper position reflects them parallel with the axis of D, which is one barrel of an ordinary field-glass. The greater part of the light passes away to the distant object, but some is taken up by the small silvered mirror, E, which is placed at an angle of 45° to the axis of D, and reflected at a right angle through the unsilvered plane mirror, F, and the convex lens, K, by which it is brought to a focus on the white screen, H, which is placed in the principal focus of K. The rays from this image diverge in all directions, and some are taken up by the lens, K, and restored to parallelism; some of these are reflected by



the unsilvered mirror, F, down to the field-glass, D, and if this is focussed for parallel rays, as is the case in looking at distant objects, an image of the sun is seen projected on the same field of view as that of the distant object. As the mirrors, E and F, are adjusted strictly parallel, the rays proceeding from F into the field-glass are parallel and in the opposite direction to those going from the mirror, A to E, which form part of the same pencil as those going to the distant object. Hence the image of the sun seen in the field exactly covers the object to which the sun-flash is visible, and in whatever direction the mirror, A, is moved so as to alter the direction in which rays are reflected to the distant object, and the angle at which part impinge on E and are reflected through the lens, K, the image visible in the glass moves in the same direction. Several attempts to produce this result were made by the use of mirrors and prisms, before the lens, K, was introduced, but they all failed. It was easy to make the image of the sun cover the object when the two occupied the centre of the field of view, but directly the mirror was inclined so as to direct the rays not strictly parallel to the axis of the field-glass, the apparent image diverged generally in the same direction along one co-ordinate, and in the opposite along one at right angles to it, so that nowhere, but in one line across the field, did the image lie in the desired position. The mirrors, E and F, are adjusted parallel once for all, by noticing the position on a screen of the small spot of light reflected from the front of F as the light passes from E to K. The mirrors are moved by the adjusting screws till this spot has, to the bright reflection from the mirror, A, the same relative position that the centre of mirror, F, has to the mirror, A.

In actual use the field-glass is first fixed in position pointing to the object, either by holding steadily in the hand, or better by a clamp attached, by which it can be screwed into a tree or post, or fixed in the muzzle of a rifle. The instrument is turned on the barrel of the glass till the sun is in the plane passing through the two axes of the instrument, and the mirror, A, is turned till the bright image of the sun is seen on the screen, H, through a hole left for the purpose in the side of the tube. On looking through the glass the sun's image is seen, and by then slightly rotating the instrument or moving the mirror, is made to cover the object. The mirror, A, is connected not directly to the body of the

instrument, but to a lever, B, on which it works stiffly, so as to retain any position in which it is placed. Lever B works easily and has a limited range of motion, to one end of which it is pressed by a spring; slight pressure with the finger moves it and its attached mirror, so as to throw the light on and off the object in a succession of long and short flashes by which letters and words may be indicated. Flashes may also be given by moving the instrument if held in the hand.

The above instrument answers well for all positions of the sun except when very low behind the observer's back. For this case another mirror is provided by which the light is reflected on to the mirror, A. Messrs. T. Cooke & Sons, York, are sole makers of this instrument.

AN ACCOUNT OF EXPERIMENTS IN PHOTO-ELECTRICITY.

By G. M. MINCHIN, M.A., Professor of Applied Mathematics in the Royal Indian Engineering College, Coopers Hill.

(Read before the British Association Aug. 1880.)

1. TWO OBJECTS OF PHOTO-ELECTRICITY.—In the study of the electric currents produced in various ways, by the action of light, I have had two objects in view, viz.:—

(I.) *The production at a distance of effects due, in the first instance, to the photographic action of light;* and

(II.) *The continuous daily registration of the intensity of sunlight of any selected wave length.*

It is at the outset evident that for the solution of the latter problem the action of the light, whose intensity is to be measured and registered, must be received on some substance whose chemical composition is either unaltered by the light, or so slowly and slightly altered during the period of observation, that the magnitude of the change may be neglected.

For the solution of the former problem it occurred to me, in the first instance, to receive the photographic action on plates coated with the silver salts in ordinary use among photographers; but I do not now think that it would be necessary to work exclusively with these substances, and if the use of them can be to any extent dispensed with, a corresponding gain would apparently result, since they are permanently and very rapidly decomposed by luminous action.

2. LUMINOUS ACTION A SOURCE OF ELECTRICITY.—It has been long known, from the experiments of Becquerel and Grove, that electrical currents can be produced by the action of light. Becquerel took two clean silver plates, exposed one to the vapour of iodine, plunged both into a cell containing a feebly conducting liquid, and completed the circuit through a galvanometer. The cell being completely covered up, the moment the circuit was completed, a strong current was set up. This current disappeared after about 24 hours. Then, on illuminating the sensitised plate, an intense current was generated by the light.

Grove used a prepared daguerreotype plate inclosed in a box filled with water, having a glass front with a shutter over it. Between this glass and the plate was placed a gridiron of silver wire, and, on completing the circuit through a galvanometer, a current was generated by the action of light on the daguerreotype plate. (See the *Correlation of Physical Forces.*)

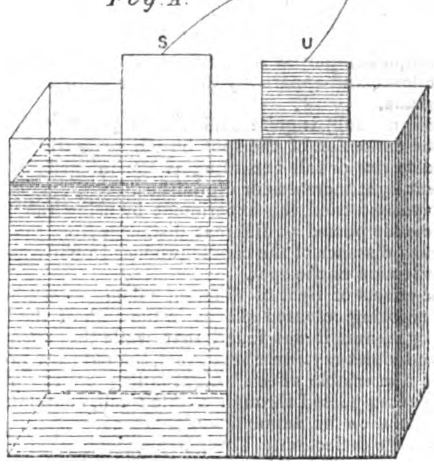
Grove also found that when two clean platinum plates were immersed in a cell containing acidulated water, and one of them was exposed to light, a current was produced. Before the light was allowed to fall on the plate there was, of course, the current which is always produced by the immersion of two plates, however similar we may succeed in making them, in any liquid. This current I shall in the sequel speak of as "the disturbing current," since it is produced by some other agency than that of light; and I shall frequently refer to it as the "D. C.," for shortness. The current produced by the action of light on one of the platinum plates was found by Grove to be *always in the same direction as that of the D. C.;* and he found, moreover, that the current produced by blue rays was greater than that produced by red.

Currents of this latter kind may be produced by the agency of light in several different ways. For instance, the two platinum plates will give the current in question if they are immersed in common tap water. Again, the two clean platinum plates may be replaced by two clean silver plates, and we shall obtain still stronger currents by the action of light on one of them. No doubt several other metals would be found to give similar results.

All such currents—viz., those generated by the action of light on any unsensitised metallic plate immersed in a liquid, in presence of a similar plate unexposed to the light—I shall in the sequel designate as "Grove's currents." They are exceedingly small compared with the photo-electric currents with which we shall be occupied.

3. PLATES EMPLOYED.—Since the substances to be acted upon by light were, in my first experiment, salts of silver, I chose silver plates in order to avoid as much irrelevant action in the cells as possible. At first the plates were simply stiff pieces of silver foil, about two or three inches long and one or two inches broad. But it appeared at least possible that much of the current was lost by passing from the coated (or

Fig. A.



sensitised) side of a plate round to the back of the same plate; and for this reason, after having already performed several experiments, I tried the effect of insulating the back and edges of the plate by a thick layer of shellac varnish. The result was a greatly improved action, and this finally led me to fix the silver

foil, by means of pitch, to rectangular pieces of glass. Thus the back of the plate was completely insulated. For the purpose of making the connections, a piece of thin silver wire, about two inches long, may be welded to the upper edge of each strip of silver foil before it is fixed to the glass plate; but binding screws will do, if care is taken to keep the portion of the silver plate which they touch from contact with the liquid in the cell.

Fig. A shows the arrangement of the two plates in the cell. The plate coated with the silver salt, or other substance to be exposed to light, is S. It stands in a rectangular glass cell, in contact with one of its faces: slightly to the side of S, and in contact with the opposite face of the cell, stands the unsensitised plate, U. In the figure we are looking at the back of U; and the whole of the cell, with the exception of the portion directly in front of the sensitised plate, ought to be covered with black paper, to prevent the access of light to the unsensitised plate.

4. NOTATION EMPLOYED.—We shall have such frequent occasion to refer to the sensitised and unsensitised plates—meaning, respectively, the plate coated with the substance to be exposed to light and the plate uncoated—that we shall, for shortness, denote them by the letters S. and U. As already stated, any current produced by agency other than that of light will be denoted by D. C.

5. THE DISTURBING CURRENT.—It may be well to state at once that the D. C. varies, both as to duration and to direction, in an irregular manner, and that Grove's observation, to the effect that its direction is always the same as that of the current generated by light in his experiments, is not true with regard to photo-electric currents generated in other ways.

6. CHLORIDE AND BROMIDE OF SILVER.—If an emulsion is formed by shaking up in a test-tube a little finely powdered chloride of silver mixed with collodion (the test-tube being, of course, completely screened from light by a covering of black paper), a silver plate coated with it in the dark, immersed in presence of an uncoated plate in a cell containing distilled water and a few grains of common salt, will, when exposed to light, give rise to a current, the direction of which is

from U. to S. in the cell.

If the liquid employed is dilute H_2SO_4, the same result follows, and apparently the current is of the same magnitude.

Sunlight (dull) is quite sufficient to give the current, and the deflection of the spot on the scale will be observed to rise or fall according as the intensity of the incident light increases or diminishes.

I have also tried the experiment by using the light of a candle placed at different distances from the cell, and each distance of the candle produced a corresponding deflection of the spot.

The effects of light of different colours were studied by interposing coloured glasses in the path of the incident light, and it was found that, while the effects of blue and violet rays were very great, the red rays gave a hardly appreciable effect. Light falling on the plate, after having passed through a thick cell, containing a dense solution of ammonio-sulphate of copper, gave also a large deflection. The galvanometer used was a Thomson reflecting galvanometer, of about 7,000 units resistance; the screen was usually placed at a distance of about a yard from the mirror; and a piece of burning magnesium ribbon, held at a distance of a foot from the plate, would cause a very rapid motion of the spot off the screen.

The plate may be coated with an emulsion of bromide of silver made in the same way, but I have preferred to use the well-known "Liverpool Emulsion." In this case the liquid in the cell was usually distilled water, with a few grains of bromide of potassium.

The current appears to be of about the same strength as in the case of the chloride cell, and the direction is still *from U. to S. in the cell.*

It is scarcely necessary to say, that chloride and bromide plates must be prepared in a photographic dark room.

I have not systematically kept a note of the direction of the D. C. with these plates, but I have noted some instances at least, in which it is opposite to that of the photo-electric current.

7. IODIDE OF SILVER.—Let a silver plate be coated, in the usual way, with silver iodide, by first pouring a layer of iodised collodion over the plate, and then immersing the latter in a nitrate of silver bath. If the liquid in the cell is distilled water, with a few grains of iodide of potassium, it will be found that the direction of the photo-electric current is,

from S. to U. in the cell,

that is, opposite to the direction of the chloride and bromide currents.

8. SULPHIDE OF SILVER.—It occurred to me that phosphorescence would probably be found to be a means of transforming luminous energy into the energy of electric current. To try this, I coated platinum and silver plates with layers of Balmain's luminous paint (rendered conducting), and then exposed them to sunlight, magnesium light, and candle light, in the usual way. Currents were certainly produced, but with such apparent irregularity that, after about twenty experiments, I abandoned the use of the paint, at least for a while.

In one of these experiments, with a silver plate coated with the paint, I obtained results apparently so anomalous that I had the plate chemically examined, and Mr. J. W. Clark found that, during the immersion of the plates in the cell, sulphide of silver had been formed. It was evident, then, that sulphide of silver should be specially examined. For this purpose I obtained some in the form of fine powder, shook it up in a test-tube with some pure collodion, and, in a photographic dark room (admitting only red light), coated a silver plate with the emulsion. This plate was immersed, in presence of an uncoated silver plate, in a cell containing distilled water, with a few grains of sulphate of potash.

The connections being made, and the cell kept in the dark, a rather strong D.C. was set up, the direction of this current being *from U. to S. in the cell.*

The light of burning magnesium ribbon, falling on S. through violet, blue, and red glasses, gave a strong current, *which in each case was in the direction opposite to that of the D. C.* Light passing through green glass gave a very small current, also opposed to the D. C.

Thus, the direction of the photo-electric currents is

from S. to U. in the cell,

or opposed to that of the AgCl and AgBr currents.

To give a rough numerical idea of the comparative strengths of the photo-electric currents produced by light falling, through coloured glasses, on an emulsion of sulphide of silver, I quote the records of two experiments:—

June 12, 1880, *Morning.—Magnesium Light.*

Two red	glasses	in front	of S.	Spot moved	violently off to left of screen
One red glass		"	"	"	" "
One green	"	"	"	"	about 50 divisions to left.
One blue	"	"	"	"	violently off to left.
One violet	"	"	"	"	" "

June 12, 1880, Evening.—Magnesium Light.

Green glass in front of S.	Spot moved 140 divisions to left.
Yellow " " "	" off to left.
Red " " "	" "
Violet " " "	" "
Blue " " "	" "
Blue and violet glass in front of S.	" "
Two red " " "	" "
Red and yellow " " "	" "
Green and yellow " " "	" 65 divisions to left.
Green and red " " "	" " "
No glass, light of a match	" 230 " "

A candle held at varying distances gave deflections varying with the distance, the distance having been varied from about six inches to about five feet.

An experiment was then tried with two clean silver plates immersed in distilled water containing a few grains of sulphate of potash in solution. Results:

Green glass	12 divisions of scale to left.
Yellow	15 " " "
Violet	34 " " "
Blue	70 " " "

and these currents were *opposed* in direction to the D. C.

I tried, in the Physical Laboratory at South Kensington, the effects of the different parts of the spectrum of the electric light on the sulphide of silver plate, but the intensity of the rays was not sufficient to give appreciable results. Magnesium light, however, falling through coloured glasses, confirmed the results before obtained.

Subsequently, at University College, I used a silver plate on which sulphide of silver had been directly precipitated, without emulsion with collodion, and exposed it in different parts of the spectrum of (not very strong) sunlight. The D. C. had not died out when the light was allowed to fall on the plate. The motions of the spot were not sufficiently marked to allow of any conclusions.

If, therefore, the experiments with coloured glasses can be relied on, it appears that *the rays at both sides of the green, when falling on a plate coated with an emulsion of sulphide of silver, give currents in the same direction, while the green rays themselves produce very little photo electric effect.*

9. NITRATE OF SILVER.—A solution of silver nitrate was mixed in a test-tube with rather thin gelatine, and a silver plate coated with the mixture was immersed, in presence of an uncoated plate, in a cell containing distilled water and a few grains of nitrate of barium. D. C. from U. to S. in cell, rather strong, and of very long duration. Light falling on the plate gave a comparatively small result.

The plate was then further washed over with the silver nitrate solution, and there was an improved result. The cell was connected up with the galvanometer all night; and next day, the spot having come to rest at 250 divisions of the scale from the zero (which was its position when no current passed), magnesium light was used with great effect.

When no glass was interposed, the spot moved a long way off the screen *in the direction opposed to that of the D. C.* With an interposed blue glass the current appeared to be nearly as strong as when no glass intervened. An interposed red glass gave a very small current, indicated by a motion of only 10 divisions, in the opposite direction. From such a small motion, however, no conclusion can be safely drawn, for the current may be only a Grove's current.

10. VARIATION OF THE CURRENT WITH THE DISTANCE.—It was pointed out to me by Professor G. Carey Foster that, other things remaining constant, the photo-electric current might be found to vary inversely as the distance of the luminous source from the sensitised plate. For the energy of the light incident on the plate varies inversely as the square of the distance: *i. e.*, it may be represented by $\frac{k}{r^2}$, where k is a constant and r the distance of the light from the plate. Also, if C = strength of photo-electric current, and R = whole resistance in circuit, the energy of the current is C^2R, so that we have

$$C^2R = \frac{k}{r^2};$$

$$\therefore C \propto \frac{1}{r}.$$

I have not yet verified this by many experiments; but I have had constructed, by Mr. Groves, of Bolsover-street, a large number of small cells, made by fixing two parallel plates of glass in an ebonite frame. These cells can be connected in series, and arranged along circles of varying radii, the incident light being in each case at the centre of the corresponding circle. A few experiments, however, made in this way have roughly agreed with the above law.

11. PHOTOGRAPHIC EFFECT OF CURRENT.—We come now to a point of fundamental importance in photo-electricity—viz., *the effect which the passage of a current through a sensitised plate has on the plate.*

The experiments bearing on this I shall quote in an order the reverse of that in which they were performed.

Two silver plates, both coated with AgBr emulsion (Liverpool Emulsion), were immersed in a tumbler containing water and a few grains of bromide of potassium. One of these plates was connected with the zinc, and the other with the carbon pole of a bichromate cell. The current was allowed to pass for a few seconds, and the result was—

1°. That the plate connected with the carbon pole was (without the employment of a developer) visibly blackened in its immersed part.

2°. That no *visible* change took place on the other plate; but when this plate was "developed" by treatment with the usual pyrogallic acid developer, *its immersed portion was also blackened.*

The effect produced on a sensitised plate by the passage through it of a current generated by light was also investigated, as follows:—

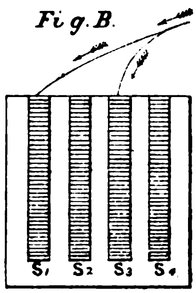
A cell containing distilled water, with a few grains of KBr in solution, was placed in a dark box; two silver plates, S′ and U′, the first coated with Liverpool Emulsion, and the second uncoated, were partially immersed in this cell; outside the box was placed a cell containing water with a little common salt in solution, and in this cell were immersed two silver plates, S and U, the first coated with an emulsion of chloride of silver, and the second uncoated. The plates in the two cells could be connected by means of silver wires which passed through light-tight holes in the side of the dark box. Previous to immersion, however, the bromide plate (in the box) was exposed for ten or twelve seconds to gas-light, the object of this being to assist the photographic action to be produced by the photo-electric current.

The circuit was completed by joining S to U′ and U to S′, and magnesium light was allowed to fall on the chloride of silver plate for some minutes. The bromide plate, S′, was then taken out and developed, and the result was that its immersed portion was very sensibly blacker than its unimmersed portion, the surface of the liquid appearing as a straight line of demarcation across the plate.

The connections were then reversed (fresh plates being, of course, used); S was connected with S′ and U with U′; and again, on development, the immerse portion of the bromide plate, S′, was blackened. It was

of course, necessary to identify the blackening effect with the passage of the current. For this purpose a silver plate, coated with the bromide emulsion, was left

Fig. B.



immersed in a tumbler containing water with a few grains of KBr in solution. After the expiration of some hours (in one instance the time was twenty hours), the plate was developed, but no blackening effect appeared.

12. LOCALISATION OF THE EFFECT.—For the solution of the problem of photo-electric transmission, it is evident that something more is necessary than the proof that the developable photographic effect is limited to that portion of the plate which is immersed in the conducting liquid. The effect must be still further localised in a conclusive manner.

For this purpose I fixed several strips of silver foil, s_1, s_2, s_3, s_4 (fig. B), on a glass plate; two or more of these strips were thrown into the circuit, the others being left out, while the whole plate was uniformly coated with Liverpool Emulsion, and immersed in a cell placed in the dark box, the liquid extending about half-way up the strips. The plate was connected with the carbon pole of a bichromate cell; and when it was removed from the cell, the blackening took place only on those strips which were metallically thrown into the circuit, *and only on the immersed portions of these strips.* One of these plates, containing two strips, was shown at a recent meeting of the Physical Society.

(To be continued.)

THEILER'S PATENT TELEPHONE TRANSMITTER.

FIG. 1 represents the outside appearance of the instrument, the dimensions of which are only 5 in. by 6 in. by 1½ in., so that the whole apparatus, containing induction coil, microphone, automatic switch and bell push, is of very small bulk. The transmitter may either be screwed or hung against a wall like a picture, and as its appearance is by no means clumsy or awkward the instrument may be fitted up in a drawing-room without disfiguring its surroundings.

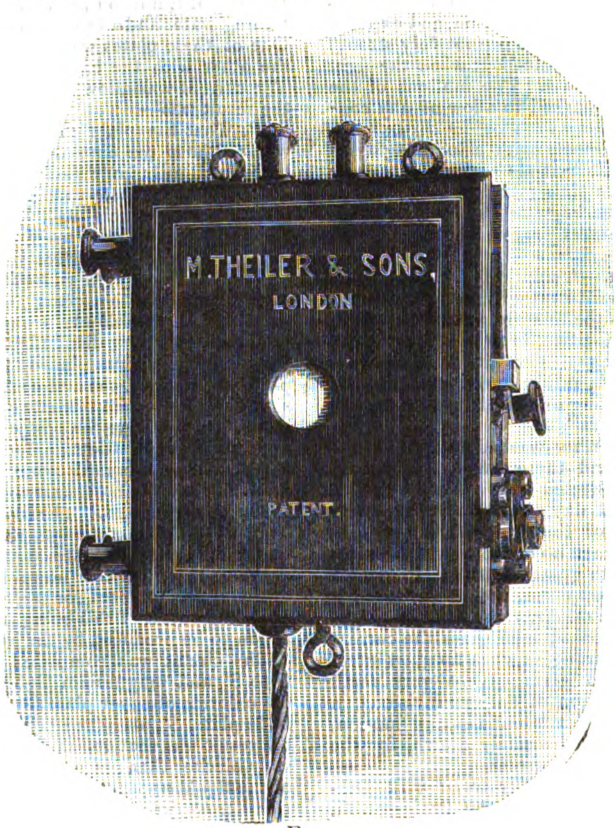


FIG. 1.

There being no adjustment of any kind, variation of temperature, &c., cannot disturb the position of its component parts.

The funnel which is required for speaking into with other transmitters is entirely dispensed with in the new transmitter. The use of such a funnel, particularly in those transmitters which require rather loud and close speaking, is not free from objection.

Figs. 2 and 3 represent the inside of the transmitter, and show the peculiar form of microphone which, after innumerable experiments with every other possible form, was found to be the best.

D is a diaphragm of Swiss pine wood or of cork. The former substance makes a highly sensitive diaphragm, while the latter is more remarkable for the great distinctness of articulation produced.

To this diaphragm two cylindrical pieces of any conducting substance, B B (fig. 3), are cemented in a parallel line, and a connection is made from these cylinders to the battery and primary circuit of an induction coil, I I, in the usual way. The circuit is closed by the rod, A (which is also cylindrical), suspended on a silk thread from the diaphragm at an angle of about 25 degrees. The nearer this suspension approaches to the perpendicular the more sensitive the transmitter becomes, but as extreme sensitiveness also includes the transmission of any, even the feeblest, noise, and imparts to the articulation a peculiar metallic twang, it was avoided by suspending the rod, C, at an angle of 25 degrees.

It will be seen that the incidence of the suspended contact piece with the fixed ones forms mathematically four sharp points, which are, however, free from the great liability to breakage or wasting away which *actual* sharp points would possess.

This feature was found to be essential to the production of a clear articulation. As there is no friction of surfaces in this arrangement, that grating rasping articulation so peculiar to common microphones is totally absent in this transmitter.

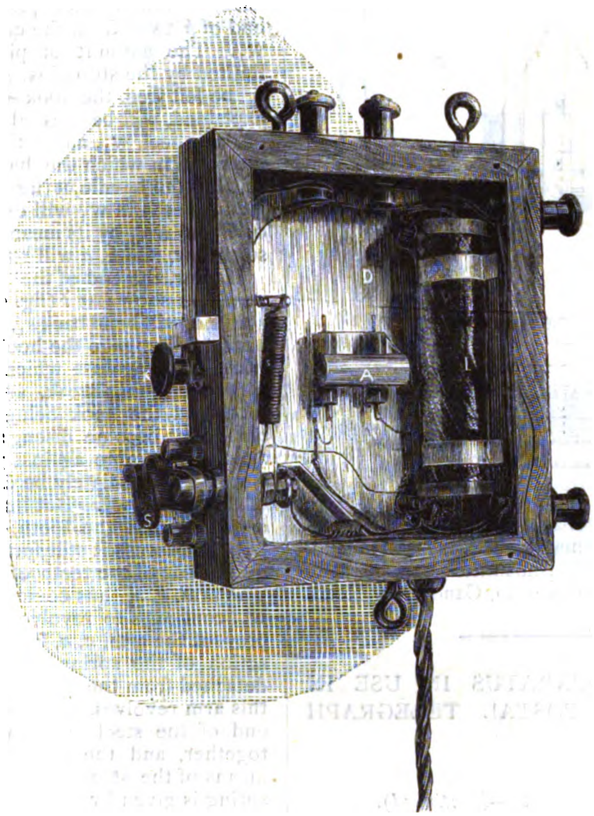


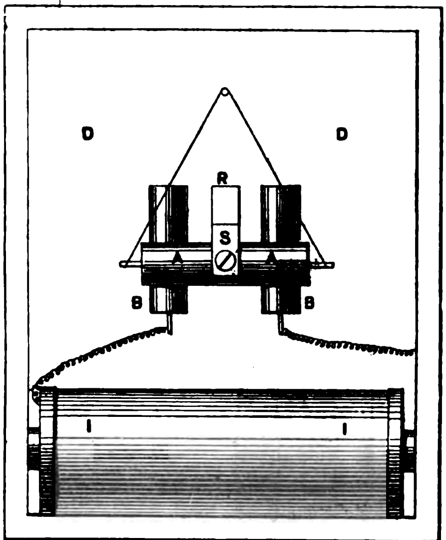
FIG. 2.

The contacts, as well as the points of suspension, being all on the diaphragm itself, it does not at all matter whether the tension of the latter be altered by change of temperature, &c., or not. If the fixed contacts should, from any such cause, change their position, the suspended contact would follow them, and their relative position would practically not be altered.

If the diaphragm is vibrated very violently (by shouting against it), the suspended piece, C, would separate from B B altogether, and produce a harsh sound in the receiver. This can be entirely prevented by the stop, S (fig. 3), which is adjustable in the bridge, R, and does not allow the piece, C, to separate from B B entirely. It is not as immaterial as is generally believed, or has been asserted, what kind of battery is used with a microphone transmitter. On the contrary, the results obtained will

differ with each change of battery; that is to say, no two cells, even of the same size and description, will give *exactly* the same results. The Leclanché

Fig. 3.



½ actual size.

is said to be the least reliable battery for this purpose, while the "Bichromate" acts very well indeed.

We may add that this transmitter can be seen working at Messrs. Theiler's, 86, Canonbury Road, daily.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XVII.

The A B C Instrument—(*continued*).

The Communicator.

In the last article the method by which the magneto currents for working the A B C Instrument were *generated*, was explained; the mechanism by means of which these currents are *controlled* is of a highly ingenious and perfect nature.

Referring to fig. 67, it will be seen that the wheel, W, which (as was explained in the last article) is geared to the revolving armature of the magneto-current generator, is turned by the handle, H. On the axle on which H and W are fixed is also attached a bevil wheel, *f.* This wheel gears into a larger bevil wheel, F, the upper portion of which is also seen in fig. 68.

To the wheel, F, is attached a second wheel, W_1, seen in figs. 68 and 69; in fact, W_1 and F are formed of one piece of metal.

Now, on turning the handle, H, it is evident that the wheel, W_1, will be turned in unison with it.

The wheels, W_1 and F, turn loose on a steel axle, *d.* To this axle, and at right angles to it, is fixed the brass arm, *a, a,* and also the iron boss, B (fig. 68). On a small piece projecting from B are secured two steel springs, *s* and s_1. The ends of *s*, s_1 are turned down, as seen in fig. 70, and between these ends is the tail-piece, t_1, of the hook, *h*. This hook hinges on a screw fixed in the arm, *a, a,* as can be seen in figs. 68 and 69.

The strength of the spring, s_1, is greater than that of the spring, *s*, so that the former tends to push the hook end of *h* against the circumference of the wheel, W_1. If, however, the spring, s_1, be pulled back, then the weaker spring, *s*, would press the hook end of *h* away from the circumference of the wheel, W_1. The amount of play which *h* can have is limited by the stop pins, *p*, p_1. Now, if the spring, s_1, be left free, the hook end of *h*, as has just been explained, will be pressed against the circumference of the wheel, W_1, and if the latter be rotated in the direction in which the hands of a watch turn, by turning the handle, H (fig. 67), then one of the projecting teeth in W_1 will catch against the hook end of *h*, and will, by its means pull round the arm, *a, a,* so that W_1 and *a, a* will rotate as one piece.

If, now, the end of the spring, s_1, which is bent round, as shown at *t* (fig. 69), comes against an obstacle, it will bend back s_1, and then the spring, *s*, will tend to disengage the hook, *h*, from the tooth of the wheel, W_1, against which it is hitched. But the spring, *s*, being weak, and the grip between the tooth and the hook being considerable, the latter would not become disengaged, unless the tail-end, t_1, of *h* also came against an obstacle. In this case *h* would immediately be disengaged from the tooth of the wheel, W_1. But immediately *h* becomes disengaged from the tooth, the spring, *s*, comes into play, and forces it still further back, thus setting it quite clear of the teeth of the revolving wheel, W_1. The arm, *a, a,* thus comes to rest, whilst the wheel, W_1, continues to revolve unimpeded. In order to prevent the arm, *a, a,* from being forced back by the action of the spring, s_1, when the hook becomes detached from the tooth of W_1, the inner end of this arm revolves, friction tight, against the inner end of the steel lever, A, the two being pressed together, and the necessary friction produced by means of the steel spring, S. The tension of this spring is given by means of the boss, *b,* which is slipped over the axle, *d,* and pressed down on the spring, S, and then fixed by a screw. The arm, A, being immovable (except between very small limits), the friction between it and the arm, *a, a,* keeps the latter held with a considerable degree of firmness in the position which it has reached at the moment when the hook of *h* disengages itself from the tooth of W_1. Thus, the spring, s_1, being unable to force the arm back, remains itself held back by the obstacle against which it, and also the tail-piece, t_1, have pressed. And therefore the spring, *s*, is able to exert its full force in clearing the hook, *h*, from the teeth of the revolving wheel, W_1.

If, now, the obstacle referred to be removed, the spring, s_1, being no longer held back, forces the hook, *h*, forward, and immediately one of the teeth of the revolving wheel, W_1, hitches against it, and the arm, *a, a,* is carried round as at first.

The obstacles against which the end of the spring, s_1, and the tail-piece, t_1, of the hook, *h*, can catch are the keys arranged around the circumference of the dial of the communicator. These keys are of the form shown by fig. 70. They are movable about the point, *i*; there is no hinge or pivot at *i*, but the long tail-piece, *i o*, is slipped down in a small slot,

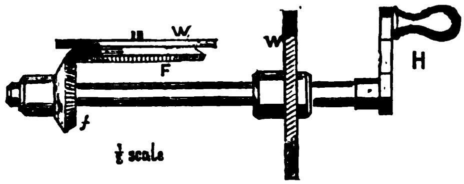


FIG. 67.

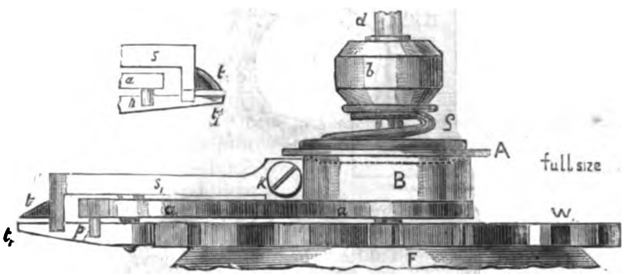
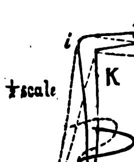


FIG. 68.

FIG. 70.



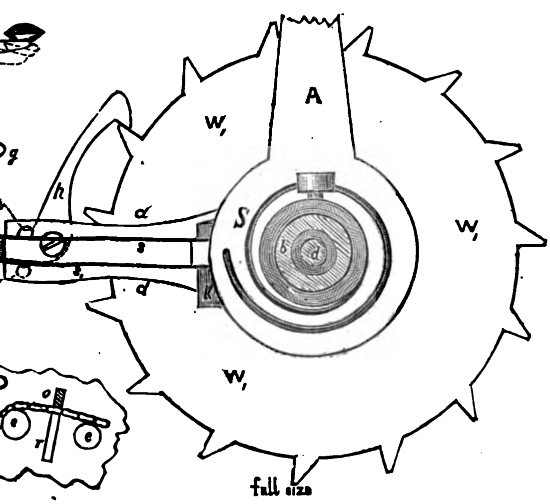
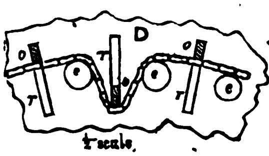


FIG. 69.

FIG. 71.



and then a brass plate is screwed down over at the point, *i*; the fitting at the angle being rather loose the key can rock to a certain extent, and thus the effect of a hinge is obtained without pivots.

In their normal condition the keys are in the position indicated in the figure, but when depressed they take up the position shown by the dotted line; in other words, the tail-end, *o*, becomes thrown forward, and forms the obstacle by means of which the motion of the arm, *a*, becomes arrested.

In order to keep a key firmly set at either of the two positions to which it may be moved—that is to say, either up or down—the small steel wire spring, *g*, is provided. The lower end of this spring, *n*, is set in a hole in one of the brass foundation plates of the instrument, and the other end is bent round at right angles and fits in a small hole in the tail-piece of the key. Now, the spring being compressed in setting it in position, it gives an upward pressure to the tail-piece of the key, and if the key were in such a position that the hole in the tail-piece lay on a line joining the points, *i* and *o*, then the key would be in equilibrium; but if the hole were to the left or right of this imaginary line, then the action of the spring would be to draw the tail-piece over to the left or right, and thus to elevate or depress the knob end of the key. The key, therefore, in its normal position is held firmly up by the action of the spring, and when depressed is held firmly down.

When any key is depressed the one which was previously pressed down becomes immediately raised again; this is accomplished by making the tail-ends of the keys press against an endless chain which passes round small brass pulleys set between each of the tail-ends, as seen in fig. 71; the length of slack in the chain corresponds to the length of movement of any one key as seen in fig. 70. The tail-ends, *o o*, move in slots, *r*, cut in the base plate, D.

The arm, A, is capable of a very slight angular movement between two contact points at its extreme end. The right-hand one of these contact points is connected to one end of the coils of the electro-magnet of the current generator, and the left-hand contact is connected to one end of the coils of the receiver. The contacts are arranged in a manner, which will be indicated in the next article, so that one contact cannot be broken before the other is made.

The arm, A, is normally drawn to the left by a small spiral spring.

On turning the wheel, W_1, and the arm, *a a*, with it, the friction between the latter and the arm, A, moves A over against the right-hand contact point and keeps it there, the friction being sufficiently great to overcome easily the tension of the spiral spring connected to the arm. When, however, the arm, *a, a*, becomes disconnected from the wheel, W_1, the spiral spring immediately draws the arm, A, back from the right-hand contact to the left-hand contact, and thus the magneto currents are cut off, the circuit being broken.

As long, therefore, as the arm, *a, a*, remains connected to W_1, and revolves with it, the magneto currents can flow, but immediately the arm, *a a*, becomes disconnected from W, through the mechanism of the former coming against a depressed key, the currents are cut off, although the armature of the current generator continues to revolve.

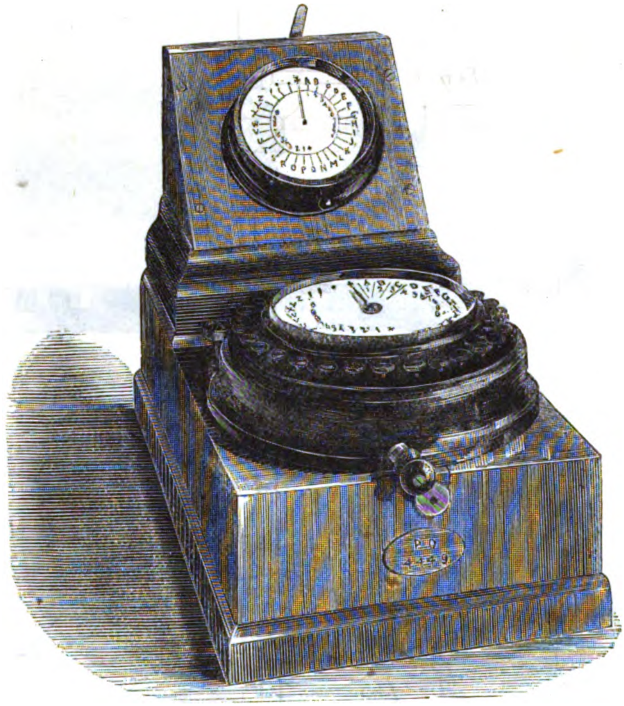


Fig. 72.

GILBERT'S NEW TELEGRAPH WIRE BINDER.

THE main objects of this Wire Binder, the invention of Mr. Gilbert, of the Dundee and Arbroath Joint Railway, are:—

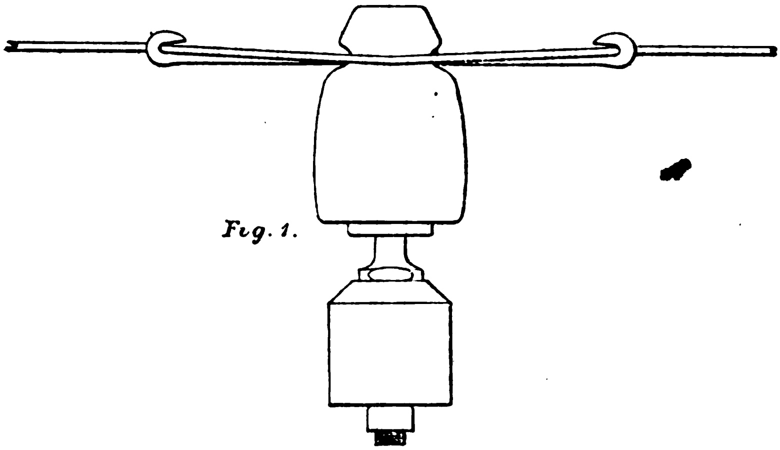


Fig. 1.

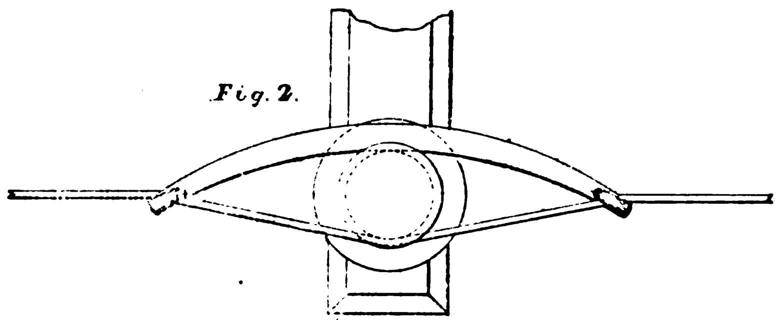


Fig. 2.

½ real size.

1st. To facilitate the erection and taking down of telegraph wires.

2nd. To reduce friction at the insulators, and the consequent breakages of the wires which occur with the ordinary wire binder.

3rd. To reduce surface contact of wires with insulators, and thereby to diminish the leakage of current in damp weather.

As will be seen from figs. 1 and 2, which represent respectively the elevation and plan of an insulator with the new binder attached, the latter is of a bow shape. It is constructed of malleable iron, and has its free ends hooked so as to embrace or grip the wire some inches on each side of the insulator. It can be applied to any insulator having a side groove, and by the most inexperienced workman in a few seconds.

Notes.

A CINCINNATI company is negotiating with the cable companies for the lease of a line for eight days, for the purpose of testing experiments for telephonic communication with Europe. It is believed that the new French line will be secured. The arrangements, it is thought, will be completed in a few days. The process upon which the proposed work is to be done is based upon the Orangbough invention of 1868 and the recent Klemm patents. The tests will be made from New York city. Only the combination of the two sys-

tems mentioned will be tested, to the exclusion of the Bell, the Edison, or any of the instruments now in active use, as the new company claim that they are actually infringing.

A DISCUSSION, which has been carried on with considerable animation for several weeks in the Edinburgh daily newspapers, on the dangers of telephone wires, has just been closed. The opinion is gaining ground that sooner or later the wires must come down.

THE s.s. *Dacia*, belonging to the Silvertown Telegraph Works Company, left the Thames on Saturday for Algiers, to lay the shore end of the new Marseilles-Algiers cable. The vessel will afterwards cross over to Marseilles, and, having laid the shore end at that place, will pay out the deep-sea portion.

CANADIAN operators are leaving for the United States in large numbers, tempted by the higher rate of wages, and the fact that expenses are but little, if any, higher than in the Dominion. Salaries in Canada are higher at the present time for strictly first-class men than they ever were before.

EXPERIMENTS are being tried at Plymouth with an electrical range-finder, the results of which will be known very shortly, and are looked forward to with considerable interest among military circles.

TELEGRAPH CABLES IN PERU.—In the House of Commons on the 7th instant, Mr. Caine asked the Under Secretary of State for Foreign Affairs whether the attention of the Government had been called to the cutting, by the Chilian authorities, of the submarine telegraphic cables laid by the West Coast of America Telegraph Company on the coast of Peru, the neutrality of which cables had been declared; and whether any steps had been taken to bring the matter under the notice of the Chilian Government. Sir C. Dilke said that the attention of her Majesty's Government has been called to this matter by the Company, who have been requested to supply further information, on receipt of which her Majesty's Government will consider whether they can properly make an official report to the Chilian Government. Her Majesty's Government will inquire as to the fact of the neutrality of the cables having been declared.

THE late Mungo Ponton, Fellow of the Royal Society of Edinburgh, whose death was recently announced, obtained the Silver Medal of the Society in 1838, for "a model and description of an improved telegraph."

AMONGST the grants of money appropriated to scientific purposes by the general committee of the British Association, are the following:—Professor Carey Foster, Electrical Standards, £100; Dr. O. Lodge, High Insulation Key, £5; Mr. J. M. Thomson, Inductive Capacity of Crystals and Paraffins, £10.

IN the place of the ordinary sulphuric acid solution, M. Agassis charges the zinc cell of a Bunsen battery with a solution composed of about 15 per cent. of potassic cyanide, potassic hydrate, or ordinary sal ammoniac, in water. With either of these solutions the zincs do not require to be amalgamated, and the constancy of the current is increased.

MR. D'ARSONVAL has effected an improvement in the ordinary gravity Daniell, by which the local action on the zinc due to the diffusion of the sulphate of copper in the cell is entirely prevented. This end is arrived at by placing a layer of animal charcoal over the sulphate of copper crystals, which effectually prevents the solution of the latter from passing into the sulphate of zinc solution, in which the zinc element is immersed. A somewhat similar device was invented by Mr. C. F. Varley several years ago; the protecting diaphragm in this case being oxide of zinc. The use of such separators, however, increases considerably the resistance of the batteries.

THE 26th annual report of the Postmaster-General has recently been issued. As regards the telegraphic department, the number of messages received during the first six months of the year was less than in the corresponding period of the previous year, but a marked increase then showed itself, and, being more than maintained, brought up the number of messages at the close of the year to 26,547,137, as against 24,459,775 in the previous year, being an increase of 2,087,362. About 313,500,000 words of news were delivered to newspapers, clubs, &c.; seventy-one new offices were opened for telegraph business, the total number of postal telegraph offices in the United Kingdom being 3,924, in addition to 1,407 railway stations. Various improvements have been effected, notably in the Wheatstone receiving apparatus, and it is proposed to provide additional wires between London and many of the principal towns. The private wire business continues to increase. The revised regulations and tariffs agreed to by the International Telegraph Conference came into operation on April 1 last. Ten years have elapsed since the telegraphs were transferred to the State, and from the particulars given it appears that, whereas the telegraph companies had at the time of the transfer 1,992 offices in addition to 496 railway offices, the Post Office can boast of 3,924 offices of its own and 1,407 railway stations open for telegraph work, or in all 5,331 offices, against 2,488 under the companies. The number of instruments in use by the companies was 2,200, by the Post Office 8,151. In 1869 the total length of submarine cables connecting different parts of the United Kingdom was 139 miles. Last year it was 707 miles. The length of pneumatic tube employed by the companies was 4,844 yards; the Post Office now employs 48,260 yards. The total number of telegraphists employed by the companies was 2,514 (of whom 479 were women), and the number of messengers 1,471. The total number of telegraphists employed by the Post Office last year was 5,611 (of whom 1,556 were women), and of messengers 4,648; but, besides these, many persons are employed in telegraph work who hold no appointment on the establishment, but are paid by the postmasters out of allowances for assistance. In 1869, about 6,500,000 messages were forwarded by the telegraph companies and railway companies transacting public telegraph business. Last year the Post Office forwarded 26,547,137 messages, or four times as many as in 1869.

THE Belgian State telegraph system employs 1,193 Morse, 52 Hughes, and 9 Breguet instruments on its lines, the length of the wire for the latter being nearly 14,000 miles.

SEVERAL tenders have been sent in for lighting the City streets, some of those firms tendering desiring only to secure a portion of the whole contract. The matter will be decided in open Court, which sits fortnightly. It is doubtful, however, if it can be considered at the next sitting; the following one will probably be the one selected for discussion of the subject. We believe there is a desire on the part of the authori-

ties to divide the contract amongst several firms and systems, so as to ascertain the best kind of light for the purpose; but this division can easily be carried too far. It seems to us that there are very few firms at present in a position to undertake the work.

AT the British Association Meeting at Swansea, the Compagnie Générale d'Eclairage Electrique of Paris, a Company which has recently been formed with a capital of 8,000,000 francs, exhibited for the first time in this county the Jamin patent system of electric lighting, the invention of Professor Jamin, Member of the Academy of Sciences of France. The light was shown in operation, eighteen lamps, inclosed in globes of various descriptions, and suspended from the roof, being used for illuminating the immense room in which the exhibition and soirées are held, and the dimensions of which are 180 feet long by 140 feet wide. These eighteen lamps were mounted in three different circuits of six lights each, and six more lamps, mounted in a fourth circuit, were distributed as follows:—

2 lamps at Mr. George Heard's saw mills, situated at a distance of about 250 yards from the Exhibition Pavilion.

2 lamps on a stall, where the various appliances used in connection with the Jamin's system, and the lamp itself, were exhibited and demonstrated by Mr. J. A. Berly, C.E., A.S.T.E., the representative and engineer in this country of the Compagnie Générale d'Eclairage Electrique, and under whose immediate supervision the whole of the plant for electric lighting was erected and fixed.

1 lamp over the principal entrance.

1 lamp outside the pavilion, lighting the approaches leading to the main entrance.

The electric current was generated by two self-exciting Gramme dynamo-electric machines, capable of feeding from 4 to 16 lights each, but arranged for 12 each. The said Gramme machines were driven by the steam engine of Mr. G. Heard's saw mill, and who kindly lent the steam-power for this occasion, as well as the use of his premises and staff. The engine was an horizontal single cylinder of 20 horse-power, and manufactured by the firm of Charles Powis, of Millwall, London. A description of the Jamin Lamp has already appeared in the No. of the *Journal* for July 1st.

THE 16th annual report of the New Zealand Telegraph Department has recently been issued. The report states that the revenue for the year was estimated at £80,000. For the nine months ended the 31st March it amounts to £53,914 13s. 5d. The gross earnings of the department for the year ended 30th June, 1879, were £112,328 13s. 9d. The total number of messages of all codes transmitted during the nine months of the year was 1,008,409, being a proportional decrease, in comparison with the previous year, of 188,432. Comparing the number of telegrams transmitted during the nine months with the letters posted during the same period, 14·27 telegrams were sent for every 100 letters. The proportion last year was 19·64. The number of money-order telegrams sent during the nine months was 11,291, representing a value of £46,425 5s., showing a slight proportional decrease in comparison with the preceding year, both in messages and value. The commission collected by the Post Office on these transactions amounts to £1,338 3s. 9d., and, after deducting the fees due to this department for telegrams, amounting to £564 11s., leaves to the credit of the Post Office £773 12s. 9d., which is equal to 1·66 per cent. on the amount transmitted. The "Urgent" and "Delayed" codes continue to increase in public favour. The former is taken great advantage of during business hours by the commercial branch of the community, while the latter is made a circulating medium for advices by travellers and trade representatives to their constituents, and for other matters where a night's delay is of no importance.

A JOURNAL devoted to telephonic interests, and called the "Telephonic Exchange Reporter," has been started in Cincinnati.

MR. BELL, of telephone distinction, is described as 32 years old. It is added that he "received a large sum for his invention, besides shares in the company, and a salary of 25,000 dols. a year as electrician. His father-in-law, Mr. Hubbard, of Boston, sold his property and embarked money in the telephone, and deserves the chief credit as the business spirit of the invention. He has made a million or two out of it, and is now in London, where a number of prominent English associates will join in companies for Egypt, India, China, and Japan."

WE have been requested to notify that, at the University of London, in the engineering department, an examination will be held on September 28th and following days, for two entrance scholarships of the value of £35 per annum, and tenable for two years. These scholarships, given by the Gilchrist trustees, are now offered for competition for the first time. Candidates must be not more than 18 years of age on the 1st October immediately succeeding the examination, and notice must be sent to the secretary of the intention to compete before the 23rd September. Besides the foregoing, a senior scholarship, of the value of £80 (half payable at the time of the award and half in the succeeding June), will, during the pleasure of the Gilchrist trustees, be awarded at the close of each session from 1881-82 inclusive.

A NEW system of fishing with a line has been invented by a German. This invention, which was exhibited at the Berlin Fishery Exhibition, excited considerable curiosity; it consists of a small skiff, which can be directed without noise to any point in the water by means of a wheel apparatus worked by a magnet. When the boat has arrived at the required place it anchors itself, whilst the line, with the hook attached, drops into the water. The little skiff contains a battery and an electro-magnet, which are so arranged that the slightest bite made by the fish closes the circuit. Immediately, with the rapidity of lightning, by means of an electro-magnet, the line, hook, and fish are jerked up, and a small bell warns the fisherman that the fish is caught.

THE Atlantic cable recently laid was completed in twelve days after the starting of the expedition from Heart's Content, Valentia.

THE eminent publishers, Messrs. W. & A. K. Johnston, are executing a series of wall-drawings on Magnetism, Frictional and Voltaic Electricity, and Telegraphy, under the direction of Mr. William Lees, M.A., Lecturer on Natural Philosophy, Edinburgh. We believe Mr. Lees is preparing a little handbook to be used with the diagrams.

EXTENSION OF THE TELEPHONE SYSTEM.—The United Telephone Company have begun to erect a wire between Dundee and Forfar. It is to be carried along by the side of the highway, and the work is expected to be completed in the course of a few weeks. The Company contemplate an extension of their wires at no distant date to Blairgowrie, Perth, Arbroath, Montrose, and other towns in the district.

New Patents—1880.

3473. "Apparatus for transmitting and receiving signals by means of electricity." A. F. ST. GEORGE. Dated August 27.

3494. "Improvements in electric lamps, in the manufacture of parts thereof, and in apparatus for exhausting them, the exhausting apparatus being also applicable to other purposes." ST. G. L. FOX. Dated August 28.

3496. "Apparatus for obtaining electricity." C. W. HARRISON. Dated August 28.

3505. "Electric signalling telegraphs and visual indicators for use thereof." W. CLARK. (Communicated by J. Van D. Reed.) Dated August 28.

3509. "Electric lamps." J. HOPKINSON. Dated August 30.

3564. "Compensating apparatus for the contraction and expansion of signal wires." C. GAUNT. Dated September 2.

3637. "Improvements in the art and means of lighting cities by electricity." P. M. JUSTICE. (Communicated by H. C. Spalding.) Dated September 7.

3670. "An improved process of regenerating the fluids of galvanic batteries in which caustic alkalies are employed, and of recovering the zinc hydrate from solution." A. M. CLARKE. (Communicated by E. Reynier.) Dated September 9.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

5206. "Electric lamps." G. G. ANDRÉ. Dated December 19. 6d. According to this invention the arrangement of parts, as described in former patent of March 1st, 1879, is reversed, so far that the base or bed plate is placed at the top, and the inclosing glass cylinder is made short and shallow, and is attached airtight to the bottom of the plate. To gain the necessary height for the carbon or carbons, the inclosing tube for same is carried up through and beyond the plate, and it is inclosed in an outer larger metal tube or casing which is fixed air-tight to the plate, and is closed airtight at the top by a removable lid. The commutating magnets when used are placed by preference on the top of the plate and outside the just named metal casing. The lower or negative electrode is carried down from the plate and may be of metal. By the employment of the short glass cylinder and the upper metal casing, as large and effective a cooling surface is obtained as is needed for keeping down the temperature of the inclosed atmosphere without using a large glass cylinder, and the replacement of the carbon or carbons is facilitated without breaking the joint between the glass cylinder and the plate by simply removing the small lid on the top of the metal casing, or the casing may be made permanently closed at the top, but it would then have to be made removable from the plate, or the joint to be broken may be in any other part of the casing. Also the invention consists of an improved arrangement of commutator for electric lamps. In order to reduce the electrical resistance of the coil of the electro-magnet, and to weaken its hold on the armature while the lamp is burning, part of the current is shunted after the armature is attracted by the armature coming against a stop or pillar, around which is placed a coil so proportioned as to take away from the magnet the requisite part of the current.

5335. "Telephones." ARNOLD WHITE. Dated December 31. 6d. (A communication from T. A. Edison.) Relates to improvements in and connected with the receiving apparatus of telephones. Patents No. 2909, 1877, and 2396, 1878. It proposes to dispense with the chemical substance previously employed with the chalk, and to use the latter alone moistened with distilled or pure water. It is also proposed to employ a metal spring or arm tipped with palladium, whereby the degree of frictional variation is increased under the action of a given strength of electric current, and a corresponding augmentation in the volume of sound is obtained. Likewise it is found advantageous to place the receiving apparatus in a tertiary circuit in lieu of the secondary circuit, a special key being of necessity used in the primary circuit when it is so placed, so as to obtain the full effect of the current from the distant station on the receiving apparatus. The tertiary circuit is opened prior to the closing of the primary circuit, so as to obviate the powerful inductive discharge directed on the receiving apparatus, which discharge has a deteriorating effect upon the surface of the chalk body of the receiving apparatus.

5337. "Automatic switches for telephones." A. M. CLARK. (A communication from E. T. Greenfield and D. McLean Adee, of Brooklyn.) Dated December 31. 6d. The object is to provide for an automatic switch, a movable electric or magnetic conductor that by its own gravity shall make or break magnetic and electric connection. It consists in a movable electric or magnetic conductor formed of quicksilver, metallic sand, or shot, or the like placed in a tube or cylinder of metal, glass, rubber, or other material, but preferably of metal that is fitted with electrical connections, so that a change in the position of the said tube or cylinder shall cause the quicksilver, metallic shot, or other conductor moving by its own gravity to make or break contact or connection between the electrodes.

1880.

3. "Combined fire alarm and fire extinguisher." W. SIMPSON. Dated January 3. 2d. Consists of a water chamber and an alarm. The firing of a cartridge cuts an electrical circuit, releasing the water from the former and setting in action the latter. *(Provisional only.)*

5. "Magnetic curative appliances." F. BAPTY. Dated January 1. 2d. Consists in bending the magnets to conform to the various parts of the body, and also in subjecting their surfaces to Baiff's protective process. *(Provisional only.)*

18. "Electric lamps." J. W. SWAN. Dated January 2. 2d. Consists in a method of obtaining a higher vacuum with incandescent lamps than has been hitherto obtained, and is effected in the following manner: after the air has been exhausted as far as possible in the well-known manner, a current of electricity is passed through the carbon so as to render it incandescent, during which incandescence the exhaustion is carried still further, until the residue of air is so small as practically not to affect the durability of the carbon.

33. "Developing electric currents for electric lights." T. ALVA EDISON. Dated January 3. 4d. Consists in a method of regulating and controlling the action of magneto-electric generators, and governing the electromotive force throughout a system of conductors, in which system are included electric lamps or magneto-electric motors.

71. "Signalling, &c., on railways." ST. JOHN V. DAY. (A communication from abroad by J. S. Williams, of Riverton, New Jersey.) Dated January 7. 2d. In

constructing apparatus to operate and govern the working and position of switches, crossings, and signals through the medium of electricity and explosive materials; the igniting or exploding in a receiver is caused to create a vacuum, and thereby cause the switch, signal, or other movable parts to be moved. *(Void.)*

75. "Dividing and regulating the electric light." A. M. CLARK. (A communication from Louis Roguier of Paris.) Dated January 7. 8d. The object of this invention is to obviate defects in existing systems, by placing in the principal circuit the part of the apparatus to be influenced by the current (as in regulators working on independent circuits), and in derivation, a resistance formed of a stick of plumbago, a platinum wire, or even a column of liquid, but preferably a carbon of small diameter and high resistance, forming a sort of auxiliary circuit. Also in a mechanical arrangement for maintaining the length of the arc constant.

79. "Producing and utilising electric currents." R. WERDERMANN. January 8. 6d. Consists of a magneto or dynamo-electric machine, the bobbin composed of a series of helices or coils, each of which is constructed and arranged to constitute an open circuit; of a series of conductors arranged in such a manner as to constitute a disc, in a bobbin; the combination of the said series of helices, each of which constitutes an open circuit, with the said conductors arranged on one or both sides of the bobbin. The brush or conducting rubber constructed and arranged in combination with the conductors. Also in the employment for lighting purposes in an electric circuit, of apparatus wherein gases are rendered luminous by silent or obscure discharges of electricity; and in an improved apparatus, whereby gases are rendered luminous by frictional electricity.

91. "Microphonic and telephonic apparatus." W. R. LAKE. (A communication from Emile Berliner, of Boston, U.S.A.) Dated January 8. 8d. Relates to improvements in microphones or contact telephones. The claims are sixteen in number.

158. "Telephonic and microphonic apparatus." L. J. CROSSLEY. Dated January 14. 6d. Consists in the construction and employment of an improved electro-magnetic telephone receiver, combining a number of armatures or receivers which convey the sound or sounds from each receiver to a common centre or ear tube; also in the method of connecting an electro-magnetic telephone receiver and transmitter with an induction coil or coils, whereby the primary and secondary currents from such coils, or the secondary currents alone, are utilised.

203. "Developing electric light." J. CLARK. Dated January 16. 2d. To provide a simpler compound of asbestos for forming the burner of electric lamps than the burner described in patent of October 9th, 1878, and in inclosing the improved burner in a surrounding globe filled with carbonic acid gas or water. *(Provisional only.)*

231. "Submarine electric lanterns." F. W. HEINKE and G. LANG. Dated January 19. 2d. Relates to a method for hermetically sealing the cylinders containing the light, and thus making them watertight. *(Provisional only.)*

250. "Electric lamps." J. W. SWAN. Dated January 20. 6d. Relates to that class of lamp in which light is produced by the incandescence of a conductor of carbon in an exhausted glass bulb, and consists in the use of caps of platinum fused to the glass of the lamp as a means of preventing the fracture of the glass by the heating of the conducting wire. In the method of forming the carbons of paper, or card bent to the required form. In forming the carbon by carbonising vegetable parchment. In employing several carbon arches in each lamp, and in preventing the evolution of gas occluded by the conducting wires within the lamp, by coating them with glass or enamel.

296. "Electric telegraphs." W. C. BARNEY. Dated January 23. 8d. Has for its object to increase the rapidity with which messages may be transmitted through long lines of electric telegraphs, and more especially through submerged cables and subterranean lines, by diminishing induction: 1st, by the use of a current of low tension; 2nd, by working under the influence of a current taken at an epoch more or less of its variable state; 3rd, by keeping the cable always in communication with the earth near to both ends.

303. "Telephone signal apparatus." W. M. BROWN. (Communicated by G. H. Bliss, of Pittsfield, Mass. U. S. A.) Dated January 23. 8d. Relates to a method of operating telephone calls, and consists in an armature-controlling device, operated by a clock or time-train, to render the signal bell of each telephone of a circuit inoperative, except at a certain moment; the moment or exact time for operating each signal bell in the circuit being different at each telephone in the circuit, and being known at the central office, so that by breaking the circuit from the central office at the proper moment, the signal for any telephone or instrument in a circuit may be operated without disturbing any other signal in the circuit. Also it consists in means for automatically regulating the movement, or correcting the time of the different clocks or time-trains in the circuit, and keeping them in unison with a central clock for each circuit located at the central office; likewise in means to shunt the circuit around the electro-magnet of each signal while the said signal is inoperative, thus effecting economy of battery power.

315. "Apparatus for generating, controlling, and utilising electricity for lighting, &c." W. R. LAKE. (A communication from E. J. Houston and E. Thomson.) Dated January 23. 1s. The first part of this invention relates to improvements in dynamo-electric machines, particularly in the use of field-magnets. Constructed as a hollow rectangular frame of iron, upon two sides of which are round coils, in such a manner as to cause the remaining sides of the frame to become of opposite polarity. The said invention also relates to improvements in regulators for electric lamps, especially in employing a shunt or derived circuit for regulating the time or interval of passage of the direct arc current through a small electric motor or engine, which alone directly controls the position of the electrodes. The claims are twenty-nine in number.

350. "Electric lamps." J. P. CELESTIN DE PUYDT and J. COUGNET. Dated January 27. 2d. Consists in the production of light from pieces of carbon, either pine or mixed with other substances, used in a closed vessel in which a vacuum or a partial vacuum is produced. *(Provisional only.)*

351. "Telephones, &c." L. DAVIS. (A communication from E. Marx, F. Aklem, J. Kayser, and A. G. Tisdel, of U.S.A.) Dated January 27. 6d. Consists of an improved telephone, the poles of the permanent magnet of which approach each other closely, one or both poles being surrounded by a helix, and one pole terminating in a thin metallic tongue to be vibrated by the induced magnetism of the helix, or by the vibration of a diaphragm of non-conducting material fitted in contact with the vibrating pole. Also relates to carbon transmitters, and consists in the employment of a diaphragm suspended upon an arm, or as a spring tongue and an adjustable spring arm carrying the carbon contact point; and also in the employment of an induction coil of novel construction.

404. "Effecting electrical connections for telephonic communication." G. WESTINGHOUSE, JUN. Dated January 29. 10d. Relates to means and apparatus whereby the electrical connections can be greatly simplified by making one wire serve for connecting the exchange with a whole group of subscribers, for which purpose, instead of leading the wire from each subscriber of a group all the way to the exchange, it is led to a switch apparatus in the neighbourhood of the group, and the switch is connected by a single wire with the central station; the switch being so arranged that when one subscriber of the group is communicating all other members of the group are excluded.

409. "Switch apparatus for telephonic and telegraphic purposes." W. R. LAKE. (Communicated by T. A. Watson, of Everett, Mass., U.S.A.) Dated January 29. 6d. Consists of a modified switch board.

436. "Apparatus for registering or recording telegraphic signals, &c." C. MCGUIRE BATE. Dated January 31. 2d. Consists of a device by which an observer can register and record marks corresponding with flashed signals transmitted to him without taking his eyes from the transmitting station. *(Provisional only.)*

City Notes.

Old Broad Street, September 14th, 1880.

MEDITERRANEAN EXTENSION TELEGRAPH COMPANY, LIMITED.—The forty-sixth ordinary general meeting of the shareholders was held on the 2nd of September, at the City Terminus Hotel, Sir James Carmichael, Bart., chairman, presiding. The report stated that the claim under the guarantee was £3,107, while there had been a slight diminution in the receipts. It having been ascertained by the Treasury that payments to the amount of £1,185 had in former years been paid in excess of its actual liabilities under the guarantee, the department had deducted such sum from the amount now claimed, less the sum of £707 16s. 6d. erroneously deducted from the last payment, and which two amounts would be respectively debited and credited to the reserve fund. They recommended payment of the usual dividend at the rate of 8 per cent. per annum, less income-tax, on the preference stock of the Company, and of three per cent. per annum, free of income-tax, on the ordinary stock of the Company, payable on and after the 7th inst., leaving £462 to be carried to reserve. The receipts from messages in the half-year were £2,036. The Chairman, in moving the adoption of the report, said that the slight delay which had occurred in calling the meeting had arisen from their anxiety to effect a complete settlement before they did meet of the point in dispute between the Treasury and themselves, and he was happy to say that the whole difference had been arranged amicably. The result was, that while the Government had insisted on the old claim of £1,185, which they had overpaid the Company in error some years ago, they had, on the other hand, agreed to waive the claim they made against the Company last year for £707. Putting one against the other the result would be that eventually they would have to pay the Government a sum of £477. He was very glad that the whole matter had now been settled, and without serious loss to the Company; and he thought the accounts had been put on such a footing that no dispute could ever arise again. The report was adopted and the dividends recommended were declared on the motion of the Chairman, seconded by the Hon. Ashley Ponsonby. The retiring directors (Sir James Carmichael, Bart., and the Hon. A. Ponsonby) were afterwards re-elected; and on the motion of the Chairman, seconded by Mr. T. Adam, Mr. Robinson was appointed to fill the vacant seat at the board.—Mr. Robinson, in reply, said they all knew that his desire was to place the Company in an improved position, so as to arrange that by the termination of the engagement they would realise some advantage by an alliance with some other company. The retiring auditor (Mr. Allwright) was re-appointed, and Mr. Hayward was elected the other auditor. A vote of thanks to the Chairman and Directors brought the meeting to a close.

W. T. HENLEY'S TELEGRAPH WORKS CO. LMTD.—The directors of this Company have decided to issue the remaining shares for £28,900 to the public. In their prospectus it is stated that the profitable work done and in hand, will, it is believed, enable the directors to pay a dividend for the first year. The present issue of shares to rank for dividend with those already allotted.

THE negotiations between the Anglo-American Telegraph Company and the Compagnie Française have, up to the present, proved futile, and have, for the time terminated.

IN the House of Commons, the other day, Sir C. Dilke, replying to Mr. Caine, said the attention of the Government had been called to the cutting, by the Chilian authorities, of the submarine telegraph cables laid by the West Coast of America Telegraph Company on the coast of Peru, and the Company had been requested to supply further information. Her Majesty's Government would inquire as to the fact of the neutrality of the cable having been declared.

The following are the final quotations of telegraphs:—Anglo-American Limited, 65¼-65¾; Ditto, Preferred, 96⅞-97; Ditto, Deferred, 36¼-36¾; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9-9¼; Cuba, Limited, 9¼-9½; Cuba, Limited, 10 per cent. Preference, 16¼-16¾; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11¾-12¼; Direct United States Cable, Limited, 1877, 12½-12¾; Scrip of Debentures, 106-108; Eastern, Limited, 9⅝-9⅞; Eastern 6 per cent. Preference, 12⅛-12⅝; Eastern, 6 per cent. Debentures, repayable October, 1883, 106-108; Eastern 5 per cent. Debentures, repayable August, 1887, 103-106; Eastern, 5 per cent., repayable Aug., 1899, 103-106; Eastern Extension, Australasian and China, Limited, 9¾-10; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 104-106; Ditto, registered, repayable 1900, 104-107; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 102-104; Ditto, ditto, to bearer, 102-104; German Union Telegraph and Trust, 9¼-9¾; Globe Telegraph and Trust, Limited, 6⅜-6⅞; Globe, 6 per cent. Preference, 12-12¼; Great Northern, 10-10¼; Indo-European, Limited, 24¾-25¼; London Platino-Brazilian, Limited, 4¾-5; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 9½-10½; Submarine, 240-250; Submarine Scrip, 2¼-2⅜; West Coast of America, Limited, 2½-2¾; West India and Panama, Limited, 1⅜-1⅝; Ditto, 6 per cent. First Preference, 7⅜-7⅝; Ditto, ditto, Second Preference, 6¾-7¼; Western and Brazilian, Limited, 7½-7¾; Ditto, 6 per cent. Debentures "A," ——; Ditto, ditto, ditto, "B," 96-99; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 34½-35; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3⅜-3⅞; India Rubber Company, 15½-16; Ditto 6 per cent. Debenture, 105-107.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 184.

THE PRODUCTION OF SOUND BY LIGHT.

THE paper of Professor Bell, on "The Production and Reproduction of Sound by Light," seems to have created considerable excitement in the scientific world generally. Should the results of his experiments prove to be well founded, a distinct step in advance will have been made in the progress of science, and this step will have been a most important one, and one reflecting the very highest credit upon the discoverer. The experiments made with selenium do not, we think, admit of any question as to their accuracy, but we must confess that we are sceptical as to the conclusions drawn by Professor Bell from the results of his experiments upon the apparent transmission of sound by the direct action of light. Considering that the supposed discovery quite throws into the shade the experiments made with selenium, since the latter, although the successful results of careful and patient experiment, were to a great extent foregone conclusions, it is difficult to understand why the alleged discovery occupied so comparatively a small space in Professor Bell's paper; unless, indeed, the author were himself not completely satisfied of the soundness of his inferences.

It is possible that Professor Bell may have made more numerous experiments than those described by him in his paper, but certainly those detailed are hardly conclusive on the point, that the observed phenomena were due to the action of light rays alone. We shall await with great interest further details of Professor Bell's experiments, and while giving him the very highest credit for the discoveries made, we must at the same time remain doubtful of the accuracy of all the conclusions drawn.

THE question as to what system is to be adopted for lighting the City thoroughfares by electricity is not yet settled. The authorities have viewed that of Jablochkoff, on the Thames Embankment; that of Brush, at Liverpool Street; and, we believe, the Crompton light, at the Alexandra Palace. Others have yet to be inspected, amongst them that of Messrs. Siemens Brothers. The decision will probably not be arrived at before the Board meeting of October 19.

THE PHOTOPHONE.

AT a recent meeting of the American Association for the Advancement of Science, an important paper was read by Professor Graham Bell. The paper was entitled, "The Production and Reproduction of Sound by Light." It was shown how clear articulate sounds could be obtained by means of a pencil of light directed upon a selenium "cell," this cell being in local metallic circuit with a battery and telephone. At the commencement of the lecture Professor Bell enumerated those persons by whose researches he had profited, including Mr. Willoughby Smith and Lieut. Sale, R.E., whose papers upon the subject of the action of light upon the electrical resistance of selenium were read before the Society of Telegraph Engineers.

It was stated that nearly all other substances possessed the property of being affected by light, but in a lesser degree, and that results had been obtained with gold, silver, platinum, brass, zinc, copper, ebonite, ivory, paper, &c., the exceptions being, as far as ascertained, carbon and glass. Carbon, it is supposed, was not acted upon in consequence of the thickness of the piece tried; but glass, if silvered, gave excellent results, and it was inferred that its transparency in the first instance prevented any effects being produced.

Professor Bell also spoke of Mr. Willoughby Smith's attempts at making resistances out of selenium, and he pointed out that some of the alloptric forms of the substance were insulating, whilst the granular or crystalline forms conducted comparatively freely.

In endeavouring to effect the object which was the subject of the paper, it was found that the lowest resistance hitherto obtained with selenium was altogether too high for the purpose, and after several experiments a "cell" was constructed, the resistance of which was only 300 ohms in the dark, and 150 ohms in the light. After explaining the form of resistance devised by Dr. Siemens, which consisted of a drop of selenium flattened between two small mica discs, a sort of gridiron of wires formed in two distinct sets being inclosed in the mass of the substance, Professor Bell explained the construction of a "cell" devised by himself. It consists of a number of brass discs, about 2 inches in diameter, separated from each other by thin sheets of mica, the mica discs being a little smaller than the brass ones, so that when the cylinder (which is about 2½" in length) is built up there will be minute interstices between the edges of the brass discs. These are filled in with selenium. Brass discs were preferred for the following reason: with other metals selenium acted like water upon oil, but upon brass it has a chemical effect which seemed to facilitate the construction by its entering into a good connection with the metal. When the brass discs were built up and clamped together they were heated until they reach a suitable temperature (about 214°), when a stick of selenium was rubbed over the edges, filling the interstices, and afterwards it was annealed, so as to render the selenium crystalline. It was explained that the annealing was a very simple matter; all that was necessary was to heat it gently until the surface became dull, just as

a mirror would if breathed upon; when that occurs it has reached its proper temper. In fact, it is safe to continue the heat a little longer, until the substance just begins to fuse, and then immediately stop the heat and set it to cool; when this has taken place the substance will be crystalline in character, and its resistance at its lowest.

The "cell" thus formed is set in the focus of a parabolic mirror.

Several ingenious plans were devised for enabling the cell to act as a medium for the transmission of sounds. For articulate speech the light rays must be undulatory. For sonorous vibrations producing musical notes a revolving disc, having holes pierced all round a short distance from the outer edge, was used.

The first form of transmitter consisted of a pair of gratings, one being fixed and the other movable and attached to a diaphragm and a mouthpiece, the movable grating being placed in front of the fixed one; a greater or less amount of light would then pass through the openings according as the bars and slits in each corresponded in position more or less, and as they were regulated in position by the vibrations of the diaphragm fixed to the grating. Behind the gratings the selenium cell was fixed, which was thus acted upon more or less by the light.

Another form of cell consisted of a square vessel with the two opposite sides of glass and a diaphragm at the bottom. It was filled with water or other suitable liquid. In the normal condition the glasses are plane, and the light passes through unaffected; but the vibrations communicated to the diaphragm give a motion to the liquid which renders the glasses convex and concave alternately, and consequently varies the effect of the light in passing. Professor Bell stated that this had recently been invented by a Frenchman, Dr. Cusco.

The simplest transmitter of all consists of a mouthpiece and diaphragm only, the diaphragm being of *silvered* microscopic *glass;* against the back of this mirror the speaker's voice is directed. The light reflected from the mirror is thus thrown into vibrations corresponding to those of the diaphragm itself.

With all these transmitters the selenium cell is placed in circuit with a telephone and a battery, and the action of the light on the cell, as modified by the action of the transmitter, by varying the current produced distinct sounds on the telephone.

With the revolving disc sending intermittent rays of light on the cell the effect was powerful. When the cell was shielded with a thin piece of "hard rubber" or ebonite, the sounds were still audible. The experiment was afterwards made of placing the piece of rubber close to the ear, and allow the intermittent light to fall on it; sounds were distinctly heard. Better effects are produced by arranging the rubber as a diaphragm and listening through a hearing tube. The diaphragm was varied, and various metals tried; antimony gave the best effect. Carbon and glass, as at first pointed out, gave no effect unless the glass was silvered. A thin disc of selenium also gave an effect, but not an intense one. Rubber was the most effective of all the materials tried.

In connection with Professor Bell's discoveries, Professor Minchin's paper will be read with interest, bearing as it does upon the subject of the connection between light and electricity.

We may mention that some months ago we witnessed some experiments by Mr. W. H. Preece, exactly similar to those carried out successfully by Professor Bell. A Siemens selenium cell was placed in the circuit of a battery and telephone, the cell being placed in a light-tight box provided with an opening opposite the cell. A revolving disc with openings was placed opposite the aperture in the box, so that light could be alternately cut off and allowed to fall on the cell with any degree of rapidity. It was anticipated that a musical note would be produced on the telephone, but no such effect could be perceived; the experiment doubtless failed in consequence of the high resistance of the selenium cell. Pressure of work prevented Mr. Preece from continuing the experiments which so nearly anticipated Professor Bell's announcements.

The subject was also discussed at the recent meeting of the British Association at Swansea, after the reading of Professor Minchin's paper on photo-electricity.

AN ACCOUNT OF EXPERIMENTS IN PHOTO-ELECTRICITY.

By G. M. MINCHIN, M.A., Professor of Applied Mathematics in the Royal Indian Engineering College, Cooper's Hill.

(Read before the British Association, Aug. 1880.)

(*Continued from page* 312.)

13. FLUORESCENCE.—In a fluorescent body the energy of certain rays is absorbed, and then given out as a radiation composed of rays less refrangible than those which the body has received. There seemed *à priori* to be reason for supposing that the transformation of energy which takes place by means of fluorescence might, under favourable circumstances, show itself by the generation of electrical current out of the energy of the incident rays. Hence I determined to try whether, if light fell on a plate coated with a fluorescent substance, a current would be generated, the other details being arranged, as in the experiments already described, with emulsions of silver salts.

This is, at present, an unverified theory; for, although strong currents are obtained from some fluorescent substances, it is probable that chemical action (due, however, to the action of light) has more to do with these currents than fluorescent transformation.

14. EOSINE.—If a very small quantity of eosine is shaken up in a test-tube with a little distilled water, and liquid gelatine then poured into the tube and thoroughly shaken up with the eosine, we obtain a beautifully-coloured emulsion of eosine with which to coat a metallic plate.

The plates which I had been previously using (with silver salts) were silver; and, in endeavouring to prove the above theory of fluorescence, these were also the plates employed.

A silver plate was sensitised, with the eosine emulsion, and, when the film had sufficiently set, this plate was immersed in presence of another in a cell containing common tap water, and the circuit completed with a galvanometer. When magnesium light was allowed to

fall on S., a violent current was set up, whose direction was

from U. to S. in the cell,

i.e., in the same direction as that given by AgCl and AgBr.

There was, of course, the usual D. C., the time of whose disappearance varied in different experiments from a few minutes to some hours.

The currents are strengthened by allowing the film to set thoroughly, so as to attain an intimate contact with the silver plate. This may be done by keeping the plate in a dry place for a day, or several days.

As usual, the effect of the rays at the blue end of the spectrum on this plate is greatest, and that of the red rays least; and I believe that in every experiment the currents produced by the different rays were all in the same direction.

An eosine plate prepared in this way has one serious drawback—viz., the readiness with which the eosine leaves the film and comes into the water.

Several attempts have been made to remedy this defect, but none have been completely successful. The best result has been obtained by pouring a layer of pure collodion over the eosine film when the latter has thoroughly set on the plate.

A plate coated in this latter way is exceedingly sensitive to sunlight. When placed in a glass cell at the top of the house, and connected in circuit with a galvanometer in a lower room, the faintest possible variation in the intensity of the light was recorded by a corresponding motion of the spot on the screen. Not only did the interposition of coloured glasses give variations of the current, but even the rapid passage of the hand in front of the cell produced backward and forward motions of the spot.

A numerical idea of the motions in question may be given by the fact that, if the equilibrium position of the spot is made to coincide with one end of the scale, sunlight falling directly on the plate will readily and rapidly drive the spot off beyond the other end.

The direction of the current generated by light is independent of any other current passing through the cell. On one occasion, when the cell was exposed to sunlight at the top of the house, and a commutator, placed on the window sill, had been used to complete connections with the galvanometer, the D. C. produced a motion of the spot to the left of the scale, while sunlight sent the spot off in the opposite direction. The connections were maintained during the remainder of the day and through the following night. Next day there was a very strong constant D. C. in the direction opposite to its previous direction. The cause of this, however, was the fact that rain had fallen and wet some solderings in the commutator, and the E. M. F. thus generated produced a strong current. Sunlight falling on the plate continued, nevertheless, to give strong currents in the same direction as before.

15. PHOTOGRAPHIC ACTION OF EOSINE CURRENT.—The current produced in this cell by sunlight was employed to produce the photographic decomposition of a bromide plate in the same manner as the current of the bichromate cell had been (Art. 11).

Two silver plates, each coated with Liverpool Emulsion, were immersed in a cell containing distilled water, with a few grains of KBr; the cell was placed in a dark box, kept in a lower room, and connected with the eosine cell on the top of the house. The sunlight at work on the eosine plate was exceedingly dull, so that it was allowed to act for about twenty hours (night included). The two bromide plates were then taken out and developed, with the results already described in Art. 11. These plates had not received a preliminary exposure to gaslight.

Two disturbing causes at present interfere with the employment of a plate thus prepared for the purpose of continuous registration of the intensity of sunlight. One of these is the weakening of the plate by the displacement of the eosine, and the other is the fact that, *on the withdrawal of the light, the spot does not at once go back to its zero position.* In some experiments the return to the zero position on the withdrawal of the light was made with satisfactory rapidity; but, especially if the action of the light had been continued for some hours, irregular motions of the spot to the right and left of the zero position, and through a considerable range of the scale, took place after the light was shut off.

For the purpose of a photometer, we must, of course, be certain that *the whole of the deflection existing at any instant is due to the intensity of the light shining at that instant*, and that if this light is suddenly removed, the deflection will cease.

16. ACTION OF LIGHT ON COLLODION.—The irregularity last mentioned suggested the propriety of covering silver and platinum plates with collodion and exposing them to the action of light.

A silver plate coated with pure collodion was placed in a cell, with tap water, in presence of an uncoated silver plate, and connected with the galvanometer. This cell was placed in the dark at the top of the house. There was on completing the circuit a D. C. from U. to S. in the cell. The cell was kept in the dark all night and most of next day. Then the D. C. had fallen so that the spot came back to 50 divisions of the scale from zero. Rather dull sunlight falling on S. gave a motion of the spot from 50 up to 150 or 200 divisions, in the same direction as that of the D. C. Variations of the current took place with those of light. When the cell was again covered up, the spot stood at a deflection of 150, instead of going completely back.

This cell (left connected all night) was used again next day. The spot started from a deflection of 40 divisions, and under the action of the sunlight reached a maximum deflection of 250 divisions, in the same direction as before. On the whole, the current seemed to vary with the intensity of the light, but several times it failed to do so.

Coloured glasses placed in front of the cell gave the most erratic and contradictory results. It seems, therefore, desirable to dispense with the use of collodion in these experiments.

When a platinum plate was coated with collodion and immersed in presence of another uncoated platinum plate in a cell containing tap water, the motion of the spot produced by sunlight was very much smaller than in the previous case; this motion extended over only 20 divisions of the scale. The small result here might, no doubt, be due to a Grove's current.

It ought to be mentioned that platinum plates coated with eosine give results very much smaller than those given by silver plates under the action of light. This fact, however, does not seem to me to be conclusive against the notion that a fluorescent body, in virtue simply of its fluorescence, can effect a transformation of luminous into electric energy; for while a silver plate, by its molecular arrangement, may be a suitable vehicle for the transference, a platinum plate may not—quite irrespective of chemical action.

17. ACTION OF MORDANTS.—To prevent the solubility of the eosine-gelatine film, the plate was washed with a solution of borax. A solution of chloride of aluminium was also tried. But, though these solutions kept the eosine in the film, they almost completely destroyed its sensibility to light.

The nearest approach to success was made by immersing the plate, which had been coated with a mix-

ture of eosine and photographic gelatine, in a strong solution of alum for some minutes. When this film had set, it answered remarkably well to the action of sunlight, and after long immersion no perceptible quantity of eosine had come off the film. The currents produced with this plate were not nearly so strong as those produced with an eosine plate prepared in the previous way, but strong sunlight gave a deflection of about half the length of the scale. About three minutes after the light was shut off, the spot returned to the point from which it started. The plate was left exposed to sunlight for over two hours, and after this time the water in the cell was not visibly coloured, although a very small quantity of eosine would have been sufficient to colour it.

With this plate the D. C. had so far disappeared after a quarter of an hour, that the spot came to 30 divisions of the scale from zero.

(*To be continued.*)

ON CURRENTS PRODUCED BY FRICTION BETWEEN CONDUCTING SUBSTANCES, AND ON A NEW FORM OF TELEPHONE RECEIVER.*

IN a communicatio to the Royal Society of Edinburgh, of date January 6th, 1879, I showed that "electric currents were produced by the mere friction between conducting substances." The existence of these currents can be easily demonstrated either by a telephone or a Thomson's galvanometer. I have since found that these currents are, for all pairs of metals which I have yet tried in the same direction as the thermo-electric current, got by heating the junction of the same two metals. They are also, approximately at least, stronger in proportion as the metals rubbed are far apart on the thermo-electric scale—the strongest current, as far as I have yet observed, being got by rubbing antimony and bismuth together. These observations clearly point to a thermo-electric origin for the currents; but it is possible that they may be due partly to the currents suggested by Sir William Thomson as the cause of friction, and partly, also, to contact force between films of air or oxide adhering to the surfaces of the metals.

Having ascertained that these friction-currents are of some strength and fairly constant, I proceeded to make several kinds of machine for producing currents on this principle. One of them consists of a cylinder of antimony, which can be rotated rapidly, while a plate of bismuth is pressed hard against it by a stiff spring. When this machine is included in the same circuit with a microphone and a Bell telephone, the current got from it is quite sufficient to serve for the transmission of musical sounds and also loud speaking. The transmitter which I have found most serviceable in my experiments is made by screwing two small cubes of gas-carbon to a violin, and placing between them a long stick of carbon pointed at both ends, the points being made to rest in conical holes in the carbon cubes. The looseness of the contact is regulated by a paper spring. This forms an excellent and handy transmitter for all kinds of musical sounds, and also serves very well for transmitting speech.

Seeing that friction between metals clearly produces a current, it seems natural to inquire if the converse held good, that is, if a current from a battery sent across the junction of two metals affected the friction of the one upon the other. I have tested for this in a variety of ways, and the results obtained leave me in doubt whether to attribute them to variations in the friction or to actual sticking produced by fusion of the points of contact through which the current passes. The most noticeable effect is produced when one of the rubbing bodies is a mere point and the other a smooth surface of metal. This led me to make a modification of the loud-speaking telephone of Mr. Edison, in order to get audible indications of changes of friction produced by the passing of a variable current. It consists of a cylinder of bismuth accurately turned and revolving on centres. The rubbing-point is made of a sewing-needle with its point bent at right angles, and its other end attached to the centre of the mica disc of a phonograph mouthpiece. It is evident that this is only a loose contact, which can be perpetually changed. When this apparatus is included in the circuit with the violin-microphone and three or four Bunsen cells, the violin sounds, as was to be expected, are heard proceeding from the loose-contact, even when the cylinder is not rotated. They are increased, however, in a remarkable degree by rotating the cylinder slowly, so much so that a tune played on the violin can, with proper care, be distinctly heard all over an ordinary room.

With regard to the explanation of this effect, it is evident that electrolysis can in no sense come into play, as is supposed to be the case in Edison's instrument. I am inclined to look for the explanation rather in the direction of the Trevelyan rocker, although the circumstances are considerably different in the two cases. In the rocker we have the heat passing from a mass of hot metal through two points of support to a cold block, whereas, in the other case, the heat is only intense at the points of contact, the rest of the metals being comparatively unaffected. The variations in the current produced by the transmitting microphone must cause corresponding variations in the heat at the point of contact of the needle with the cylinder, and this again produces a mechanical movement of the pressing point, as well as of the air surrounding it, sufficient to give forth sound-waves. If such be the case the effect should be different for different metals, those answering best which have the lowest thermal conductivity and also the lowest specific heat. That this is really so is shown by substituting cylinders of other metals for the bismuth, all other things remaining the same. In this way I have compared lead, tin, iron, copper, carbon, and find that they all give forth the simple loose contact-sound when the cylinder is stationary, but that it is only with bismuth that there is any very great intensification of the sound when the cylinder is rotated. Now, by consulting the appropriate tables, I find that bismuth is a fraction lower than any other common metal in specific heat, while it is much below them all in thermal conductivity. This seems to bear out my explanation to a certain extent.

* Abstract of a paper read before the Royal Society of Edinburgh, by James Blyth, M.A., F.R.S.E., on May 3rd, 1880.

ON THE BEST FORM OF MAGNET FOR MAGNETO MACHINES.

By W. LADD.

(Read before the British Association, August, 1880.)

At the British Association Meeting at Dundee, in 1867, I made some remarks upon different forms of magnets, and exhibited diagrams, showing by the lines of force—naturally arranged—the great superiority of the circular magnet where an armature is to be employed.

Since that time, some thousands of that form of magnet have been made for medical, mining, and other purposes.

Some months ago, in conversation with M. Breguet, of Paris, I showed him these same diagrams, and he was very much impressed with their importance; he has since then constructed a machine using the Gramme armature, and with a smaller quantity of steel in the magnets he has made a far more powerful machine than hitherto constructed with either the Jamin or the ordinary horse-shoe form. It is also more symmetrical in appearance and occupies less space.

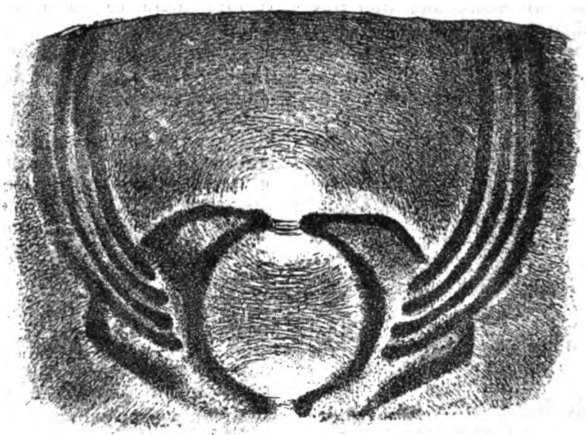


Fig. 2.

With this machine I can heat to incandescence 19 inches of platinum wire by four turns of the handle, while to heat 14 inches of the same size wire by a machine having a Jamin magnet, it took ten turns of the handle.

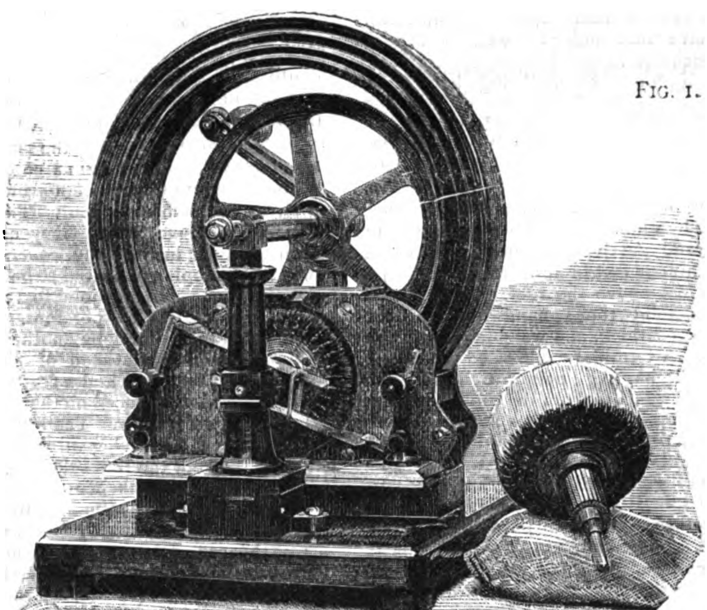


Fig. 1.

[This machine is shown by fig. 1. Fig. 2 shows the distribution of the magnetism about the field in which the armature revolves.]

ON THE NECESSITY FOR A REGULAR INSPECTION OF LIGHTNING CONDUCTORS.

By RICHARD ANDERSON, F.C.S., F.G.S.

(Read before Section A of the British Association, August 27, 1880.)

ONE of the most valuable suggestions which has been made in connection with Lightning Conductors was that by M. W. de Fonvielle, in his paper "On the Advantages of keeping records of Physical Phenomena connected with Thunderstorms," read before this association in 1872. In that paper M. de Fonvielle referred to the steps taken by the French Government for having maps drawn of the course followed by thunderstorms; and he reminded the association that the French Academy of Sciences, as far back as 1823, recommended the Government of France to establish a record of cases of damage by lightning to buildings which had been supplied with lightning conductors. He pointed out that the efficiency of lightning conductors had been questioned, and that in Manchester, a conference, held on the occasion of Kersal Church being struck, had arrived at the conclusion that lightning conductors were worse than useless.

Although it was suggested by M. de Fonvielle, that this association should establish some organisation for the collection of such data, no results have, so far as I am aware, been published.

In my paper "On Lightning Conductors and Accidents by Lightning," read before this association in 1878, I cited two cases of damage to buildings provided with lightning conductors, which showed that on a careful investigation of the facts the lightning rods were inefficiently erected.

On the present occasion I wish to bring under the notice of the association a few cases of damage resulting to buildings which had lightning conductors attached, which have come under my own observation. The adducing of such cases furnishes the best argument, I imagine, not only for a record being kept of all accidents; but of a regular inspection of buildings which have lightning conductors attached to them.

On the 10th of October, 1878, a furniture repository, situated at the back of Victoria Station, Westminster, was struck by lightning, although a conductor was attached to the building. The warehouse, which is built of brick, is 110 feet by about 80 feet wide; the roof is flat and covered with lead. At the south-east corner a slate-covered tower, with four feet of iron cresting, rises to the height of 20 feet above the roof. To this ornamental ironwork a solid copper band lightning conductor, $\frac{3}{4}''$ broad × $\frac{1}{8}''$ thick, and weighing ·43 lbs. per foot, was attached. A terminal made of $\frac{5}{8}''$ dia. copper tube, with three discharging points 6 inches long, screwed into the rod 3 inches from the top, rose 3 feet above the iron cresting. The rod was attached to the ironwork by means of copper wire, and the band to the slates and brickwork by gun-metal clips. The copper was of very good quality, having a conductivity of 92·00 per cent. The electric discharge fell on the point of the lightning conductor, bending it, driving out two of the discharging points, and twisting the third. The iron cresting was shattered, and considerable damage done to the tower. Part of the discharge was, no doubt, carried off from the lead roof by the rain-water pipes, which were in metallic communication with it. On testing the conductor shortly after the accident I got no deflection of the galvanometer needle, and on opening out the earth terminal found the conductor carefully insulated in concrete.

On the 10th of June last, lightning struck the point of the conductor at St. Mark's Church, Skelton, slightly bending it, but did no further damage. The conductor was made of $\frac{5}{8}''$ dia. copper rope, and had a conductivity of 52·50 per cent. On testing the conductor, while rain was falling, I found the resistance to be 600 ohms. The conductor was buried 9″ among bricks, lime, &c., and carried 15 feet from the building.

On Saturday, the 26th of June, 1880, a heavy thunderstorm passed over South Lambeth, the lightning doing considerable damage to All Saints' Church. The building in question, the style of which partakes of the characteristics of the thirteenth century, consists of a nave 92 feet 6 inches long, 25 feet wide and 36 feet high to the plate level of the roof, a chancel 31 feet long, 20 feet wide and 48 feet to the ridge; also north and south aisles 13 feet 3 inches wide. A stone cross 4 feet high stands on the apex of the west gable, and another of similar size stood 92 feet 6 inches from it on the east end of the nave, a ridge of red tiles separating them. A $\frac{5}{8}''$ dia. copper-rope conductor, consisting of 49 wires, was attached to the cross on the west gable, a 5 feet point, made of copper tube, rising 18 inches above it. On the afternoon of the 10th lightning was observed to strike the point of the conductor, then dart to the stone cross on the east nave, throwing it down and injuring the roof of the north aisle. On testing the conductor, a few days after the building was struck, I found the lightning rod had no "earth" whatever, the rope being simply stuck 2 inches in loose rubbish. The copper was very impure, the conductivity being only 32·10 per cent., or about double that of iron.

In July last, about half-past five in the morning, lightning struck one of the chimneys of Normanhurst Court, near Battle, Sussex, notwithstanding a lightning conductor was attached to it. Normanhurst stands on high land, and commands a magnificent view of the whole channel from the South Foreland to Beachy Head. The buildings are constructed of hard blue stone, roofed with Brosely tiles, and are in the style of the age of Francis I. There were two lightning conductors on the buildings; one on an octagonal tower which rises from the S.W. angle, having a balcony and a lofty stone spire, about 120 feet high; the other on the S.E. chimney, which was struck, about 126 feet distant from the tower. The lightning conductors consisted of 12 copper wires, 15 B.W.G., woven into the form of a band an inch broad, and weighing ·36 lbs. per foot. The air terminal, which rose 3 feet above the chimney coping, consisted of an iron point 12 inches long, covered with a composition which on scraping appeared to be lead, this was attached by means of a coupling-joint to a copper tube 6 feet long, and weighing ·28 lbs. per foot. The copper band was connected to the rod by another coupling-joint. The chimney coping consisted of eight ornamental stone pinnacles 3 feet high and 2 feet square at the base. The terminal rod was placed on the centre of the chimney—and insulated from it. The lightning discharge struck the chimney, destroying three of the pinnacles, which falling through the roof below did considerable damage. The air terminal was bent, and the composition on the point melted 3 inches. The wires near the terminal point were likewise partly fused, and on taking out one wire 25 feet below the terminal rod, I found it so irregular in thickness that it had to be redrawn before the conductivity could be determined. On testing the earth terminal I could get no deflection of the galvanometer needle, the conductor being buried in dry earth within a stone wall 8 feet above the fosse, or asphalted area. The conductor on the tower had "good earth." The conductivity of the copper was 80·5.

In my recently published work on "The History and Application of Lightning Conductors," the following cases, among others, are given.

On the 6th of August, 1878, lightning struck the powder magazine at the Victoria Colliery, Burntcliff, Yorkshire. At the time of the explosion the magazine contained about 2,000 lbs. of gunpowder. The magazine was an oblong building of brick, 9 feet long, 5 feet wide, and 6 feet high (internal dimensions), and it had a uniform thickness of three bricks. At the end was a heavy iron door, and at the other a lightning conductor, consisting of a copper wire rope seven-sixteenths of an inch in diameter. The point of the terminal rod was about 13 feet above the top of the building, and a similar length was carried into the ground, and terminated in clayey soil at a depth of three feet. The conductor was fixed to a pole distant about 2 inches from the end of the building opposite to that in which the iron door was fixed. *It was not connected with the iron door in any way.* On testing the conductivity of the copper rope it was found to be only 39·2 instead of 93 or 94 per cent. The conductor should not have been insulated, but brought down the pole, carried along the roof, down the iron door-post, and so into the ground.

In August, 1879, lightning struck one of the pinnacles of the tower of Cromer Church, Norfolk, although on another pinnacle only 27 feet 6 inches distant, a good copper conductor having a diameter of $\frac{5}{8}$ of an inch was placed. On testing the conductor by means of a galvanometer I found it and the earth connection in thorough order. In this case a point should have been placed on each of the pinnacles and joined to the main conductor.

In May, 1879, the steeple of the Church at Laughton-en-le-Morthen was struck by lightning and damaged. The spire, 175 feet in height, had attached to it a thin tube made of corrugated copper, about $\frac{7}{8}$ of an inch in external diameter and $\frac{5}{8}$ internal; the copper being $\frac{1}{32}$ of an inch in thickness. It was made in short lengths joined together by screws and coupling-pieces, but there was no metallic contact whatever between the pieces, which were much corroded. The conductor was not in contact with the building, but was kept at a distance of $2\frac{1}{2}$ inches by 21 insulators. The earth contact was obtained by bending the tube and burying it in the ground at a depth of from 6 to 18 inches, the soil being dry loose rubbish, the earth terminal being only 3 feet. It was placed in a corner formed by a double-stem buttress, which came between the conductor and a lead-covered roof attached to the spire; the distance between the conductor and the lead roofing being about 6 feet 6 inches. The lightning appears to have come down the conductor a certain distance, and finding the road to earth bad, it passed through the buttress, dislodging about two cartloads of stone, and then down the cast iron pipes leading from the lead-covered roof, and so to earth.

From the instances quoted, it is evident that it is not sufficient merely that rods of copper should be attached to a building, but it is necessary that once put up they should be regularly inspected to see if they are in good order, so as to be really efficacious. That this is rarely done is one of the main reasons why accidents by lightning occur in places nominally protected by conductors. It is, perhaps, not too much to assert that at present not one in a thousand of our public buildings in England are regularly tested.

There can be no manner of doubt that in the matter of lightning conductors they manage things better on the other side of the Channel than with us. The French Government are in the constant habit of consulting the most eminent scientific men on the subject of protecting public buildings against the destructive influence of lightning. There is scarcely an instance in which a British Government ever did such a thing. It is true the Houses of Parliament had lightning conductors erected upon them at a very great cost and under scientific advice. But all who understand the subject practically agree in saying that it is very doubtful whether the magnificent pile of buildings in which our legislators assemble is really, that is efficiently, protected. At all events, I understand the earths have never been tested since the conductors were erected in 1852. That the Victoria Tower should have been struck in June, 1868, and slightly damaged, tends to show that the conductors at that time were not in an efficient state.

From the examination I have made I am pretty correct in stating that one half of our cathedrals and three-fourths of our churches have not even nominal protection. For all that science has done, the Queen might any day be killed in her apartments at Windsor Castle, the Prince of Wales in Marlborough House, and the Prime Minister in Downing-street. To see the difference between England and France in this respect, one has but to cross the Channel between Dover and Calais. At Dover there are huge barracks of great length, on the top of high hills, exposed to the full fury of storms sweeping across the Channel, and the few conductors to be found upon them at long intervals are certainly not numerous enough for efficient protection against lightning, and their efficiency has never, so far as I can learn, been tested. The contrast in this respect on crossing the Channel is of the most striking. At Calais, the Hotel de Ville, in the Grand Place, literally bristles with lightning conductors, and so do all the churches and chief buildings in the town. The same all over France, Germany, and Belgium. Without slavishly imitating our scientific neighbours, we might yet bestow some of the care they do upon the protection of our property as well as of our lives against the terrible effects of the electric force.

TROUVÉ'S ELECTRIC MOTOR.

By M. TROUVÉ.

IF the dynamic diagram of a Siemens armature is traced out, on making the armature turn a complete revolution between the magnetic poles which react upon it, it will be observed that the work is almost nil during two periods forming a considerable portion of the revolution. These two periods correspond to the times during which the cylindrical poles of the armature, having reached the poles of the magnet, move in front of them. During these two portions of the revolution, which are each about 30°, the magnetic surfaces destined to react one on the other remain at the same distance, and the armature has no turning force given it.

I have suppressed these periods of indifference and increased the useful effect of the machine, by modifying the shape of the bobbin; the polar faces, instead of being portions of a cylinder of which the axis coincides with that of the system, are of a snail form, so that on turning they gradually approach their surfaces towards those of the magnet, up to the moment when the hinder edge leaves the pole of the magnet. The action of repulsion then commences, so that the dead point is practically got rid of.

Fig. 1 shows a general perspective view of a motor constructed on these principles; fig. 2 is a vertical section of the same, with a horizontal projection.

Fig. 1 is drawn to half size. A A C C is a fixed

electro-magnet or inductor; B a Siemens armature on the new principle mounted on pivots, I J.

This motor is capable of working a sewing machine with a few Bunsen or Reynier cells.

As matters exist at present, it is doubtful if this motor can be employed by a working mechanic, as the expense to him would be comparatively considerable; it would be, however, very useful to dentists or clockmakers, &c., or to amateurs, and for numerous special purposes. The success of this motor, and the different results arrived at, are easily explained by the following enumeration of the peculiarities which it presents: 1st, it gives in a comparatively small space a considerable power; 2nd, the electro-magnetic effects are utilised under the best possible conditions, as the inductor is very close to the induced armature, and since it almost entirely envelopes the latter. Fig. 2 shows a vertical section with a horizontal projection of the motor. *a a b* is an electro-magnet with two branches, and which forms the inductor; *f f e e* is the movable armature. 3rd, the complete suppression of dead points, with a single movable electro-magnet, a fact very rare in mechanism, which would have produced an immense effect in science if it had been applied to the steam engine instead of to an electric motor; 4th, the direct reaction of two magnets, the one on the other, placed in the same circuit, allows of the augmentation of the power indefinitely by an increase in the current strength—this power is only limited by the strength of the machine; 5th, a considerable velocity can be attained even up to 200 turns a *second* and beyond; 6th, no sparking at the commutator, the current being never interrupted (it changes only as in the ordinary Siemens armature, at each revolution); 7th, it may be added that this motor is reversible, and can, by slight modifications, be employed as a generator of electricity; 8th, it is not expensive, costing from 100 francs upwards.

Figs. 3, 4, 5, are varieties of the motor, in which M. Trouvé has arrived at good results by making the inductor excentric, instead of the armature.

Fig. 6 represents an ingenious application of the Trouvé motor to the propulsion of light boats. The arrangement is in effect so simple that it does not require any change in the construction of the boat to be made.

The rudder carries on itself all the mechanical elements; the motor, the propeller, and the conductors are easily added.

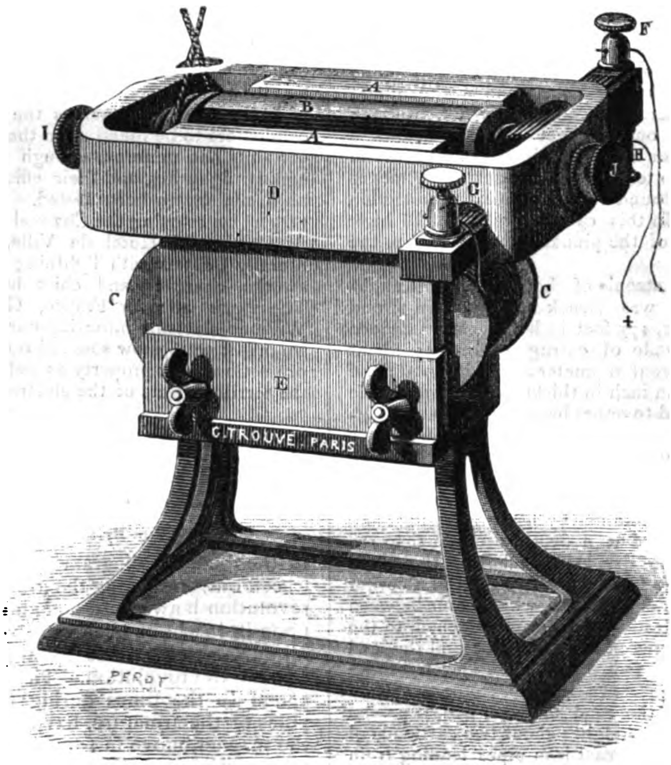


Fig. 1.

The screw and its axis occupy the lower part of the rudder, and receive the movement of the motor placed on the top of the rudder by means of a connecting band or by some other means.

The electro-motive force furnished by the generator which is placed in the boat is conducted to the motor by flexible metallic cords.

The power given out by the motor is transmitted to the axis of the screw by means of a band, as explained above.

The rudder is fitted to the boat in the ordinary manner, by a hook and loop.

It keeps in every respect its movability as an ordinary rudder; it allows besides the use of oars to increase the speed of the boat.

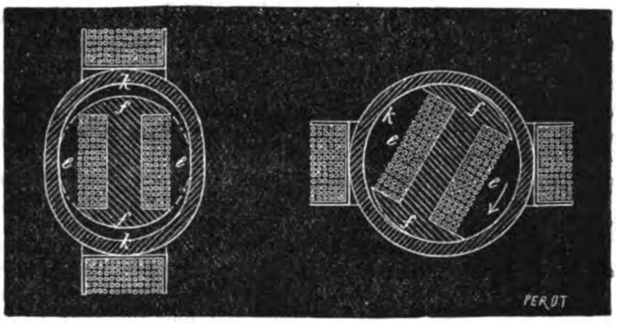


Fig. 4. Fig. 5.

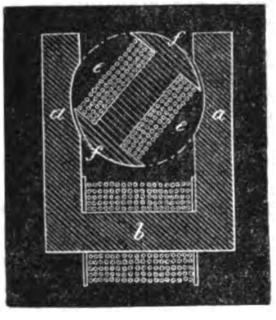


Fig. 2.

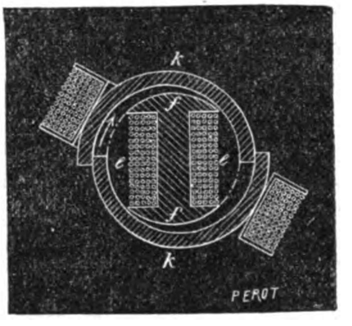


Fig. 3.

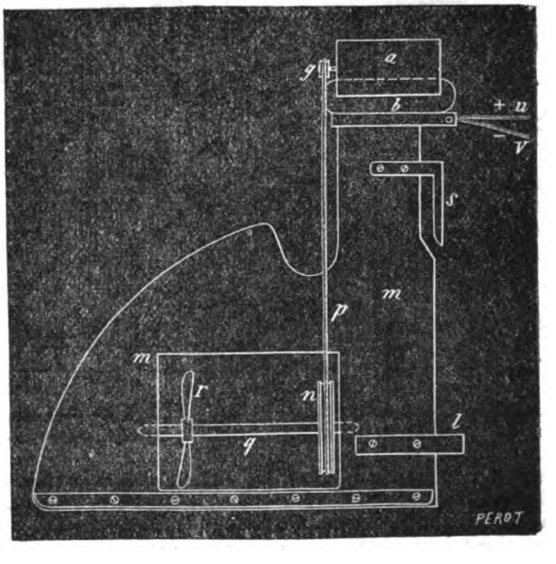


Fig. 6.

When it is required to use the oars alone, the screw not being acted upon by the motor can turn freely.

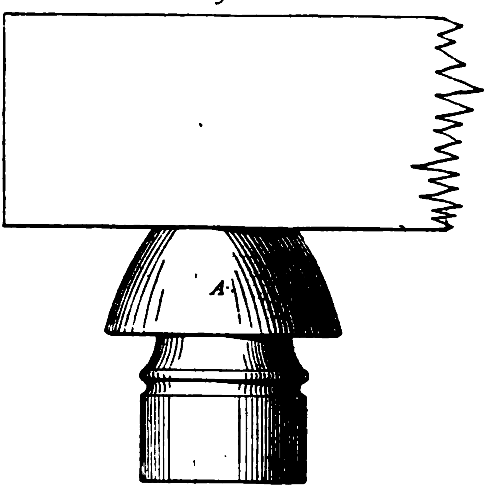
For several months numerous experiments have been made on the river Seine, with this motor arranged in the manner indicated, and fitted to a pair-oared yawl, the *Telephone* belonging to M. Ed. Schlesinger. In the experiment the yawl attained a speed of 1·20 metres per second. After certain modifications of details, this speed was successfully increased to 2 metres per second, with the stream against the boat.

These results were obtained with the small motor, of which fig. 1 is a half-size representation, presented to the Académie des Sciences; the battery power was 6 Reynier elements.

BLOOMFIELD'S PATENT INSULATOR.

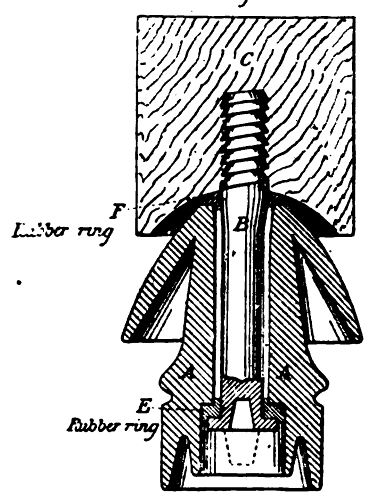
This insulator, the invention of Mr. John H. Bloomfield, of Concordia, Entre Rios, Argentine Republic, is designed specially for South America, to prevent breaking, from the expansion of the iron shank, in a climate subject to sudden changes of temperature, in which it is impossible to maintain the insulation of a line in a good state without frequent renewals. Where this insulator is used, the "Hornero," a species of "Furnarius" (F. rufus)—a bird well known in South America, which builds its nest of mud on the telegraph brackets and insulators—cannot cause "weather contact" or "earth;" on the contrary, by building its nest on the cross-arm or bracket, right over the insulator, it will improve the insulation, as its nest would be a protection in wet weather. Suspension insulators, in which the wire is hung in hooks, have this latter advantage also; but the wire breaks frequently in the wedges, or cams, of the stretching insulator in frosty weather, and runs down a long way through the hooks. They are also heavy and expensive, and liable, in common with all others, to be broken by the expansion of the hooks, hoods, or cement.

Fig 1.



Elevation

Fig 2.



Section

Fig. 1 is a side view of one of the improved insulators. Fig. 2 is a longitudinal section of the same.

A represents the insulator, which is designed to be made of glass, porcelain, or glazed brown ware, with a convexed upper end, a concaved lower end, and a downwardly-projecting cup-flange around its upper part covering the part around which the wire is to be fastened. The porcelain cup, A, is perforated longitudinally to receive the screw, B, by which it is secured to the lower side of the cross-bar, C, attached to a pole.

The perforation is made a little larger than the body of the screw, B, so that the porcelain cannot be broken by the expansion of the screw.

The lower end of the perforation through the porcelain is countersunk to receive the head of the screw, B, and the head has a square hole or cavity formed in it, in line with the axis of the screw, to receive a key for screwing it into and out of the cross-bar, C.

Upon the body of the screw, B, within the upper and lower parts of the perforation through the cup, are placed two rubber bands, to fill up the space between the screw and cup, and keep the latter firm and steady.

Upon the body of the screw, B, at its head, is placed a rubber ring, E, which is made a little smaller than the head, and which, when the screw is turned up into place, is pressed into the countersink in the

porcelain, A, and around the outer edge of the screw-head, so as to cushion the screw-head and keep it from coming in contact with the porcelain cup.

Upon the screw, B, at the upper end of the porcelain, A, is placed a rubber ring, F, which, when the screw is turned up into place, is pressed into the upper end of the space between the screw and cup, and between the cup and the cross-bar, C, so as to cushion the insulator to the cross-bar.

By this construction the porcelain cup, A, is kept from contact with the screw, B, and the cross-bar, C, and the screw is allowed to expand without breaking A, and to contract without loosening it.

The under side of the cross-bar, C, is concaved to receive the upper end of the cup, A, to protect it from the weather.

With this construction, should an insulator be broken a new one can be secured in place with the same rubbers and screw that secured the old one, so that the line-repairer will only have to carry a small key and a number of insulators, no nails, hammer, screw-driver, screws, &c., being necessary.

Should it be desirable to use iron-hooded insulators, the "South American" can be made so, by placing a perforated inverted iron cup on the screw between the caoutchouc ring and the cross-arm or bracket; this gives all the advantages of the ordinary iron-hooded insulator, with none of its drawbacks.

The loss and waste of material is less with this insulator than with any other, as the parts are interchangeable, the screw and rings of one answering for the porcelain cup of another. This is an important consideration in ordering supplies for renewals, as only the parts required need be ordered, thus reducing the expense of maintenance and freight.

Where a wire is broken it often runs down from three or four poles on each side of the break, tearing off or breaking the insulators, and loosening the posts. A good deal of this would be avoided with the new invention, as, owing to the caoutchouc rings, each insulator acts as a spring, and lessens the shock.

Experience has shown that if a telegraph line is examined a month after it has been put in repair, particularly if there have been any frosty nights, followed by warm days, a good many insulators will be found cracked, loose, or with incipient cracks, showing that their efficiency as insulators is very much impaired; and if the lineman does his duty, he should carry a number of insulators with him, depending on the length of his line, every time he patrols it. With the above insulator all this would be avoided, as the insulator cannot be injured by the expansion of the screw. If this insulator were to get broken, the wire would not drop to the ground unless the porcelain was broken piecemeal, because the binding wire will keep the pieces together, and the head of the screw being underneath prevents them from slipping down.

WE understand that Professor Graham Bell has arrived in England from America.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XVIII.

A B C INSTRUMENT—(*continued*).

THE general arrangement of the internal and external connections of the A B C instrument will be seen from fig. 73. Fig. 74 shows the arrangement by which the currents from the Communicator are sent out to line and cut off.

As has been explained in the last article, when the revolving arm is hitched to the wheel driven by the Communicator, the arm, A, is pulled over from left to right. Now the end of the arm, A, is forked, and has two prolongations, *a* and *b*, the latter of which has a platinum tip. This tip then presses against the end of the lever, *l*, and makes contact with it; at the same time it presses away *l* from the contact screw fitted to the insulated column, F, and banks it against the screw fitted to the insulated column, E, the circuit is then complete between terminals 6 and 7, through the electro-magnets, thus: from 7 to E, thence through *l* to the arm, A, and one end of the coil of the electro-magnet, then through the latter to F and terminal 6. If now the arm, A, falls back, the fork, *b*, breaks contact with *l*, and the fork end, *a* (fig. 74), comes against the ebonite piece, *c*, fixed to the end of *l*, forcing the latter back against the stop screw fixed to F, if the spring attached to *l* has not already done so. The circuit now from 6 to 7 is complete, thus: from 7 to E, thence through *l* to F, and from the latter to 6. The electro-magnet coils are thus cut out of circuit.

It will be seen that the lever, *l*, cannot break away from the screw stop of F, until the end, *b*, of the arm, A, comes against *l* and forces it away, but when this occurs, the arm, A, must be in communication with *l*. There must, therefore, either be a short circuit between 6 and 7, or the coils of the electro-magnet must be in circuit, a disconnection between 6 and 7 cannot occur. In the old forms of apparatus the end of the arm, A, played between two contact points, one of which was connected to one end of the coils of the electro-magnet and the other to terminal 6; the arm, A, was connected to one end of the coils and to terminal 7 through the frame of the instrument. With this arrangement it sometimes happened that the arm, A, or "rocking lever," became set intermediate between the two contacts, thus causing a disconnection and breaking down the circuit, with the new form of rocking lever as described this never occurs.

The external and internal connections of the "Receiver" portion of the apparatus are shown in the upper part of fig. 73. The terminals and brass-plate connections are fixed to the back of the receiver. With the switch turned to (T) the course of the current, from terminal 7 of the communicator would be:—to terminal 3, thence through the switch lever to brass plate 5 and through the coils of the receiver, thence to brass plate 1 and on to the terminal connected to the latter; from there the current passes to the "Down" line.

When the switch lever is moved over to (A), then the course of the circuit from terminal 7 is:—to terminal 3, thence through the switch lever to brass

plate 4 and to the "Bell" connected to it. From the bell the circuit is complete to terminal 5, and thence through the communicator to the Down line.

Terminals 1 and 2 screw into a brass plate cut at *h*. In the case of a thunderstorm coming on a brass strap, s, can be made to connect the two, and thus the Up line be connected direct to the Down line and the instruments cut out of circuit and be prevented from sustaining damage.

The wires of the "lightning protector," which is fixed inside the receiver case, are connected to plates 1 and 3. The brass case of the protector is connected to a terminal placed immediately below terminal 4; this terminal is connected to earth.

The line connections shown are those for an "Intermediate" station. At an "Up" station, terminal 6 is put to earth, and at a "Down" station terminal 1 is put to earth.

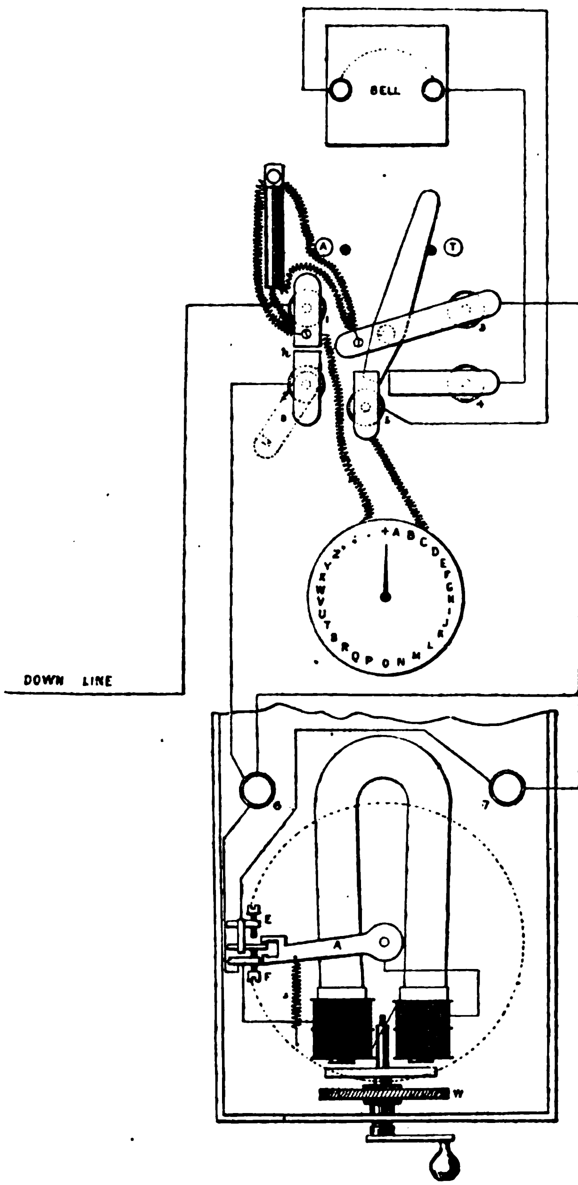


Fig. 73.

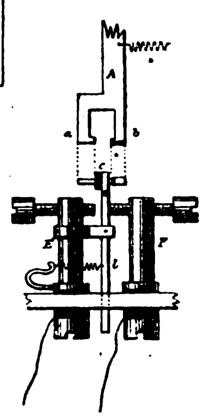


Fig. 74.

Faults.

Care must be taken that the switch lever makes a good rubbing contact with plates 4 and 5; it

occasionally happens that a disconnection takes place on one or other of these points. A contact in the lightning protector will interrupt the working of the apparatus. This fault can be ascertained by connecting a galvanometer and battery to terminals 1 and 3, the other terminals being free, and the switch turned to (A); no deflection of the needle should be produced.

There also should be no contact between the brass case of the protector and either of the terminals 1 and 3.

An A B C instrument, in good order, should work well on short circuit through a resistance of 11,000 ohms. The communicator coils are wound to a resistance of 500 ohms, and the receiver coils to a resistance of 150 ohms.

These instruments have proved so satisfactory that more than 10,000 have been manufactured. Over 5,000 are in use in the Postal Telegraph Department.

THE ROYAL ENGINEER TELEGRAPH TRAIN AT ALDERSHOT.

The Royal Engineer Telegraph Train at Aldershot, under the command of Major Hamilton, lately returned from the Zulu campaign, affords a gratifying instance of the smartness and efficiency attainable by our scientific corps from frequent actual practice in the field.

The equipment of the troop is contained in twenty-four waggons, each drawn by four horses, carrying two drivers, and attended usually by a non-commissioned officer and six men on foot. Six of the waggons are coaches fitted up as offices, while two others each carry a boat for crossing deep water. Thirty-six miles of india-rubber covered copper strand wire—the core 0·3 inches in diameter, and braided with hemp—for running out on the ground, and thirty-four miles of bare copper wire (No. 22 B. W. G.) for aerial lines, are carried on drums. Each drum contains half a mile of core, and six drums, revolving on fixed axes, are carried in the body of a waggon. Under the drums are placed twenty telescopic iron gas-pipe standards, eighteen feet long, for erection at road, stream, and canal crossings; three log-line stays, with iron spikes and wooden cleats, are supplied for straining up taut each standard, and a small wooden top-piece to contain the covered wire, with a wedge to prevent its hanging low over a crossing. On actual service, of course, any length of aerial line of copper or thin iron wire can be run up, and trees, bamboos, or such jungle props as can be obtained locally, would be employed for supports. This aerial line would follow in the rear of an advancing force, while the covered core would be used for running out on the ground to connect the flanks with the main body, and the latter with the reserve and baggage. In crossing an open country the ground line is run out at the respectable rate of five miles an hour, inclusive of stoppages for erection of pairs of telescopic poles at road crossings. While the waggons are on the move and the wire is being paid out the men busy themselves in putting it out of harm's way as much as possible—inside hedges and fences, behind furze bushes, over palings, on the roofs of cottages, or in covered trenches at crossings where the length of the poles is insufficient to carry the wire clear of baggage waggons. When the wire is to be recoiled the waggon is turned back over the same route as that by which it advanced; an india-rubber endless band is passed over the axle of the drum and over that of a wheel concentric with and fixed to the hind wheel of the waggon, so that as the latter progresses the wire is coiled on the drum; a man walks behind to let the wire pass through his hand (protected by a leathern glove), to remove timber and to guide it on to the drum.

The receiving instruments for the offices are "direct inkwriters," consisting of a lightning protector, a key, a galvanometer, and a polarised sounder, resembling a Siemens relay, turned on its side with the tongue lying horizontal, connected with the usual clockwork arrangement for paying out the tape; these are all on one base-board. These recorders will work through fifty miles of the wire used, but for field work are unnecessarily cumbersome and complicated; greater despatch would be secured were the men taught to read by sound exclusively from a small simple or polarised sounder. Such an instrument of 200 ohms resistance would work through 150 miles of wire with a small battery power, and would certainly be cheaper and more portable than that in use; and the time now expended in translating the message from the tape record would be saved.

The battery cells used are those of the Leclanché "Gravity" form, and are fitted into ordinary wooden troughs; one chamber contains zinc and a solution of sal-ammoniac, and the other carbon and peroxide of manganese; sawdust, well packed into the tops of the cells, prevents spilling of the solution. These batteries are worked on the "closed circuit" system, and it is a question whether small-sized Daniell's cells in troughs, excited by sulphate of copper, sal-ammoniac, or common salt, in default of other salts, would not be found more constant for a continuous current.

Notes.

The Secretary of the United Telephone Company, Limited, has written the following to one of the daily papers: "Referring to the 'communication' in yours of Saturday last, I am desired to inform you that the parties by whom no doubt it was made, and who constitute the so-called Gower Bell Company, represent one or more of the scores of telephone patents which have been taken out since (and therefore subject to) the original Bell and Edison patents, the latter being now invested in this company in the same manner as the corresponding patents for the United States are vested in the National Bell Telephone Company of America. The license held by the Gower Bell parties under the Bell patent is of a restricted nature, and is subject to the payment of a royalty to this company. They have no license under the Edison patent, and (as they have raised the question) it is but right to warn the public that their carbon transmitter is an infringement of this company's patents, and that all persons using it will be proceeded against as infringers."

With reference to the above, we have it on good authority that the Gower Bell Company have taken similar steps to those formerly taken by Mr. Crossley

under like circumstances—namely, they have issued notice of a writ of injunction to restrain the United Telephone Company from issuing any such circulars.

The patent for the Crossley Microphone Transmitter has been sold to the Universal Telephone Company, Limited (Bell and Edison Companies combined), of London. We presume the already commenced legal proceedings of the Edison Company against Mr. Crossley will, in consequence, be abandoned.

The law-suit between the Government and the Telephone Companies, we hear, is likely to come on about November. It is said the Government refuses any compromise before the action is tried, but is open to make good terms after it is decided.

Mr. David Brooks of Philadelphia, who has been superintending the laying of his underground telegraphs at Waterloo, and on the Continent, was to sail on Saturday, the 25th ultimo, from Antwerp for home.

Messrs. Clark, Muirhead & Co. are, we understand, about to manufacture the machines and lamps for the Lontin Company.

A statement has been going the round of the papers to the effect that "Messrs. William Cooke & Co., Limited, of Sheffield, have just secured the largest Government order for telegraph wire that has been given out for many years. The order amounts to about £20,000, and the wire is intended for telegraph purposes in India." This is undoubtedly a very nice order, but the statement is incorrect. Even so recently as this year a larger order was placed by the Government for about £23,000 worth of wire, the contract being made with the well-known manufacturers, Messrs. R. Johnson & Nephew, of Manchester and London.

Mr. Fawcett, the British Consul-General at Constantinople, has been notified that the assassins of Mr. Anderson, the agent of the Eastern Telegraph Company in Crete, have been sentenced to fifteen years' imprisonment.

Messrs. Samuel Brothers, of Ludgate Hill, who, previous to the destruction of their premises, used the Jablochkoff system for the illumination thereof, have now contracted with the "Compagnie Generale" to light their new warerooms on the Jamin system. They decided on this method after having received a very favourable report of the use of that system in Paris, by the firm of carriers called the "Messageries Nationales," and at a music hall; the said report being furnished by a scientific gentleman whom they instructed to witness and examine the light at those places.

The Edinburgh Police Commissioners have accepted the tender of the United Telephone Company for connecting telephonically the head police-station with the district stations, and the Edinburgh and Leith head police-stations. The erection of the wires is being rapidly pushed forward. The wires at present connecting these places are worked with Wheatstone's A B C's, and are maintained by the post-office.

The port of Havre will shortly be illuminated by the electric light, the Minister of Public Works having sanctioned the agreement with the Societe Generale d'Electricite.

Messrs. Harrison & Son, of Darlington, have recently put the ironstone mines of Messrs. Stevenson, Jaques & Co., at Boosbeck, in telephonic communication with the smelting furnaces at Acklam, a distance of about 15 miles. The wires pass through Messrs. Stevenson, Jaques & Co.'s offices at Middlesbro', where a set of telephones are also fixed, and the three places —Boosbeck, Middlesbro', and Acklam—can thereby carry on a conversation with each other all at the same time, and orders may be verbally given from the central office at Middlesbro' to both places at once, or to each separately, as may be desired. The speaking, which is most distinct, is transmitted by Hunnings' Patent Micro-telephones, and the effects of induction from contiguous telegraph wires are stated to be entirely overcome by it. In addition to this communication between Acklam, Middlesbro', and Boosbeck, a wire has been carried down into the mine itself, and it is thereby possible for the people at the furnaces at Acklam, or in the offices at Middlesbro', or Boosbeck, to speak direct to the men in the mine itself at Boosbeck.

The machines of the Brush Electric Light Company in Montreal Harbour, having successfully stood the long-continued tests to which they have been subjected, have finally been taken over by the Harbour Commissioners. They have ordered besides five additional double lamps, making in all twenty-one lights which will be available for illuminating purposes.

The Herz Telephone and Induction apparatus, which is stated to have successfully solved the problem of telephoning through submarine cables, was patented in this country in July and August last.

From some experiments made by Dr. Obach, it appears that the electrical resistance of selenium is affected by phosphorescent light, though to a small degree only.

The Museum of Practical Geology in Jermyn-street, is, it is said, to be illuminated by the electric light during the coming winter.

The Swiss Federal Council, granting a concession to a Telephone Exchange Company in Zurich, have fixed the duration of the grant at twenty years, whilst a tax is imposed of 10 francs (8s.) for each subscriber.

The Anhalt Railway Company has adopted the Bell telephone as a means of communication between its offices and stations.

At the recent meeting of the British Association, a committee on Electrical Standards was formed, consisting of Lord Rayleigh, Sir W. Thomson, Professors Adams, Ayrton, Foster, Fleeming, Jenkin, and Perry, Messrs. Hockin, Hopkinson, Lodge, Muirhead, and Preece. The principal object of the committee is to revalue the ohm.

Eight miles of the track on the Canden and Amboy Railway, New Jersey, are to be worked experimentally by electricity. The experiment will be looked forward to with great interest.

A small pamphlet on "The Electric Light for Industrial Uses" has been published by Mr. R. E. Crompton. The pamphlet contains a great deal of useful, practical information.

A company is to be formed in America, with a capital of 4,000,000 dollars, under the title of "The American Rapid Telegraph Company." By the use of improved automatic instruments a rate of 1,000 words

per minute is to be attained. The system is the invention of Messrs. T. M. Foot, C. H. Randall, and F. Anderson.

Brooks' Cable.—Some recent tests of the Paraffin Oil Cable, laid down by Mr. Brooks some months ago in Belgium, show very satisfactory results. The following are the tests:

Dates.	Resistance in megohms per kilometre, after 10 minutes' electrification.	Temperature.	Weather.
4/6/80	361	$12\frac{1}{2}$° C.	Rain.
19/6/80	211	$23\frac{1}{2}$° C.	Fine.
25/6/80	290·8	$17\frac{1}{2}$° C.	Rainy.
2/7/80	277·38	$21\frac{1}{2}$° C.	Fine.
10/7/80	237·9	16° C.	Rainy.
16/7/80	365·8	18°—21° C.	Rainy and stormy.
27/8/80	209·7	$14\frac{1}{2}$° C.	Fine.
3/9/80	205	28° C.	Fine.
13/9/80	249·2	19° C.	Fine.

The tests were taken by M. J. Dumont.

The Western Union Company is now engaged in building an entirely new line of the largest wire used for telegraphic purposes, which is to be quadruplexed and used exclusively for cable business.

On Wednesday, September 8th, lightning fell on the Sorbonne at about half-past two o'clock. A globe of fire was observed by persons present on the spot. Some of them say it was seen coming from the point of the north-western conductor, which was struck, as well as the south-western, with a great noise. The Sorbonne had, until recently, no lightning conductor, and never, as far as is known, has any thunderbolt struck the venerable abode of the French University. But within the last few months six stems have been erected and connected by an iron bar, making a circuit which goes all over the roof of the immense building. Unfortunately, the pit where the earth conductor has been placed is situated at a great distance from the main building, in a courtyard adjoining the laboratory of M. Jamin, and the conductor which connects the roof with this is a square iron box of less than 15 mm. on each side, so that there is not sufficient conductibility in it to establish an efficient connection with the earth. This accident proves the sagacity of M. Karsten, the Schleswig-Holstein physicist, who published a table giving a formula for regulating the dimensions of the connecting-rods with their lengths, as is taught by Ohm's laws. It shows also how little the knowledge of lightning-conductors is spread in France, in spite of the several official commissions which have been established by the Government.

During the severe thunderstorm which recently passed over North London, a peculiar phenomenon was witnessed in the grounds of the Welsh Harp, Hendon, by some gentlemen boating on the lake. A vivid flash of lightning was succeeded by a tremendous peal of thunder, a great ball of fire at the same time descending from the heavens into the water. When the storm had abated, over 100 fish of various kinds, including two fine carp, weighing together 23 lbs., were found floating dead on the lake.—*Nature.*

Charterhouse Science and Art School and Literary Institute.—We have been requested to state that the winter session of this, the largest science school in the United Kingdom will, under the continued presidency of the Rev. J. Rodgers, V.C. of the London School Board, commence on Saturday, the 25th of September. During the late session about 800 students availed themselves of the privileges afforded by this institution, and of this number nearly 600 presented themselves for examination, and were successful in obtaining no less than 140 Queen's Prizes, awarded by the Science and Art Department of South Kensington. At a nominal fee instruction of a practical character is given in most of the sciences, whilst in art, at an equally low rate students, under the direction of four competent instructors, can be advanced in their studies. Those who aim at becoming proficient in chemistry (organic and inorganic), have the opportunity of working in a well-fitted laboratory, capable of holding sixty students. Aspirants for University honours can, at a small expense, be assisted in their studies. Lessons in Latin, Greek, French, German, and music, are given by well qualified teachers. Full particulars can be had of the organising secretary, C. Smith.

Telephone Convention.—Arrangements have been made at the International Hotel, at Niagara Falls, at a reduced rate, for delegates to the Telephone Convention, which is to be held there on the 7th inst. The hotel proprietors will furnish a room for the meeting of the convention, and have a number of excellent rooms where manufacturers and dealers can display their apparatus, &c., for the use of which they can make favourable arrangements.

The coming convention will open the eyes of a good many to the vast importance of this new branch of telegraphy. It is not long since the telephone compelled the British Government to call a halt—when the latter attempted to interfere with the introduction of the system in England—and in this country its importance has scarcely received the recognition which it deserves. It is barely more than a year since telephone stock advanced from 50 dollars to 1,000 dollars a share—at which price it was privately marketed last summer—and most people will be astonished to learn of the remarkable growth of the system. At the beginning of 1879 the Bell Telephone Company had in use in America about 12,000 telephones; a year later it was working 50,000, and there are now in use upward of 85,000 instruments of its own manufacture, and, perhaps, 25,000 from the Western Union offices. We should not be surprised to hear that by next New Year's they have 200,000 instruments in use, and five years hence a half a million will probably be found in active operation.—*Magnet.*

The system of underground pipes for telegraph wires in Berlin consists of 33,373 m. iron pipes and 460 m. passages of mason-work, and contains 155 apertures for examination and repair of the lines. The cost amounts to 229,867 marks.

Correspondence.

S.—We have lost all record of the source from whence the note in question was derived; but we fancy that Professor Jenkin and Ewing's experiments on "Current curves from sound waves" were described in a number of *Nature* of about the date when the note was written.

New Patents—1880.

3765. "Improvements in electric lamps and in carbons or incandescing conductors therefor, and in means for and methods of manufacturing the same." E. G. Brewer. (Communicated by T. A. Edison.) Dated Sept. 16.

3784. "Electric type-printing telegraph apparatus." G. J. Droste. Dated Sept. 18.

3808. "Dynamo machines." F. G. Willatt. Dated Sept. 20.

3809. "Improved means and apparatus for dividing and subdividing the electric current for lighting purposes." J. B. Rogers. Dated Sept. 20.

3832. "Improvements in or applicable to dynamo-electric machines." W. Elmore. Dated Sept. 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

455. "Lamps for electric lighting." T. H. Blamires. Dated Feb. 2. 6d. Describes forms of lamps in which the production and maintenance of a vacuum is obtained by means of one or more columns of mercury, the passing of the conducting wires through the glass being obviated, and Sprengel and air pumps being dispensed with.

471. "Telephonic apparatus." H. H. Lake. (A communication from G. L. Anders and T. A. Watson, of U.S.A.) Dated Feb. 3. 6d. Provides at each station a switch permanently connected to line, which switch can be moved so as to connect the line to earth at each station, or to disconnect the line from earth; an electro-magnet operated by the main line current, and moving the switch by the return movement of its neutral armature when the current through the said electro-magnet is broken; a polarised armature affected by the main line current, and arranged so as to determine the movement of the switch in one or the other direction according to the polarity of the current, by the interruption of which the movement of the switch is effected by signalling apparatus operated by alternate positive and negative currents of such force or duration as not to attract the neutral armature; and a locking device which prevents the signalling apparatus at any station from being operated except when the line is grounded at that station.

478. "Electro-magnetic and dynamo-electric machines." T. Morgan. (A communication from Nicolas Glouchoff, of Moscow.) Dated Feb. 3. 4d. This specification describes machines based, so it states, on the following principle—namely, that all galvanic currents, induction and Ampère, have an angular direction imparted to them, which arrangement enables the number of conductors to be reduced to a minimum, thereby diminishing the objectionable resistance, and at the same time enabling the whole of the copper or iron wire employed for working the machine to be utilised to the best advantage. Commutators are replaced by continuous metal discs, simple rubbers, or even troughs containing mercury, serving to conduct the current to the exterior of the apparatus. (*Provisional only.*)

495. "Method of and telephone for determining the direction of sound." A. M. Clark. (A communication from A. M. Mayer, of the U.S.A.) Dated Feb. 4. 6d. Describes the topophone, which invention incidentally includes means of adjusting two resonators at variable distances from each other; means of varying the lengths of one or both of two connecting tubes; a suitable frame for the support of the various parts of the apparatus, affording an axis of oscillation which is substantially perpendicular to a line drawn from one resonator to the other, and a pointer which is substantially perpendicular to the axis of oscillation and to a line drawn from one resonator to the other. The invention may be employed either upon land or water, but its principal object is to facilitate the safe navigation of a vessel in a fog. In the latter case a base line is obtainable by sailing the vessel an observed distance in a straight line from one point of observation to the other. The resonators are first tuned to the pitch of the sound to be observed, by sliding their telescopic joints in or out until the normal pitch of the resonator corresponds to the pitch of the sound to be observed. The resonators are then adjusted equidistantly from the shaft, at a distance from each other slightly less than the wave-length of the sound under observation. The shaft, being then held in an upright position, is slowly rotated upon its longitudinal axis until the mouths of both resonators touch the same sound-wave surface. The observer, having the ends of two tubes from the resonators applied to his ears, will perceive a sudden augmentation in the intensity of the sound when the mouths of both resonators touch or nearly touch the sound-wave surface. The position of the pointer then coincides in alignment with a line drawn from the source of sound through the place of observation.

553. "Regulators or lamps for the electric light." G. W. Wigner. Dated Feb. 9. 8d. Consists in the use of a fluid—such, for instance, as water—contained in a reservoir situated above the regulating apparatus, or of fluid under sufficient pressure to force it to a height greater than that of the regulating apparatus, as the motive-power by which the electrodes are caused automatically to approach each other, and in the use of the electric current itself or a portion of it to automatically regulate the supply of this fluid.

578. "Electric lamps." T. Alva Edison. Dated Feb. 10. 8d. Refers to incandescent lamps, and describes a method of manufacturing them so that a stable vacuum may be maintained therein.

583. "Electric railways, &c." Carl Heinrich Siemens. (A communication from Dr. E. W. Siemens.) Dated Feb. 10. 6d. See Telegraphic Journal, Feb. 15, 1880.

602. "Utilisation of electricity for light, heat, and power." T. Alva Edison. Dated Feb. 11. 8d. Relates to a method for supplying electricity generally to a city, town, village, or locality. These may form one district, or, if the extent of territory makes it desirable, may be divided into several districts. In each district is provided a central station, at which are grouped a suitable prime motor or several motors, each motor driving a number of magneto-electric machines. The inventor makes his field of force magnets extremely long, and of an extremely large mass of metal in proportion to the mass of metal in the revolving armature carrying the generating coil. By this extra length, as the magnetic tension at the poles increases with their distance apart, there is secured at the polar extensions acting upon the coils in the revolving armature a much greater magnetic intensity, or, so to speak, a greater magneto-motive force or pressure, causing consequently the generation of a greater amount of energy in the coils operated on than would result from the use of shorter magnets. By this elongation of the cores the inventor is enabled to dispense with a number of layers of coils, as one layer of wire is usually sufficient,

whereby the resistance of the machine is largely diminished. The large mass of these magnet cores is magnetically saturated by a weak current passing around them. It takes this weak current a long time to bring this mass of metal up to the point of practical maximum magnetic intensity; but once brought to that point, the weak current readily keeps them there, while with a shorter magnet a stronger current would more speedily magnetically saturate them: this stronger current would still be required to keep them so saturated. The claims number thirteen.

624. "Manufacture of engine packing, insulated telegraph wires, &c." G. F. JAMES. Dated Feb. 12. 2d. Refers to the hopper or funnel of the braiding machinery hitherto employed in the manufacture of engine packing, &c., in which china, clay, or other lubricating powder or liquid is introduced, and forms either a core or coating of the same. (*Provisional only.*)

630. "Lighting by electricity." The Hon. R. T. DUDLEY BROUGHAM. Dated Feb. 13. 2d. Intended to reduce the rate or to prevent the consumption of carbon or other electrodes used in electric lighting. The inventor combines the electrodes with a liquid carbonaceous substance, such as an oil or syrup, by immersion before or during the use in the lamp, or by supplying or feeding such carbonaceous substance to the electrode while the lamp is in operation. During the emission of the lights the volatile constituents of the carbonaceous liquid are driven off by the heat generated by the electric current, and the carbon is left in or on the electrode. (*Provisional only.*)

631. "Telephones and phonographic apparatus." F. H. F. ENGEL. (A communication from Dr. W. Klinkerfues, of Göttingen.) Dated Feb. 13. 6d. Consists in the application of an uninterrupted galvanic current to speaking telephones whilst in use. The application of one or more metal tubes filled with mercury, into which dip platina pins (which pins have broad bases), either connected to the diaphragm of the instrument or moved by its oscillations, for the purpose of producing a contact of vibrating or varying size. Also consists in the reinforcement of the variations of the current by several imitating diaphragms of several telephones intercalated between the elements of the battery, and in the gathering of the sounds or words of all imitating diaphragms in one hearing trumpet.

636. "Producing the electric light." A. M. CLARK. (A communication from C. L. Pilleux, of Paris.) Dated Feb. 13. 6d. Consists in the interposition between two ordinary rheophores of one or more carbons, whereby (according to their number and distances apart) either a single luminous arc is formed by the juxtaposition of two sparks, or two luminous points united by a voltaic arc extending between the points of the carbons placed between the rheophores, but without traversing the length of the said carbons.

638. "Electric telegraph apparatus." W. R. LAKE. (A communication from B. Thompson and C. Selden, of Toledo, U.S.A.) Dated Feb. 13. 6d. Relates, first, to means for the sending of telegrams by induced currents of opposite polarities, one polarity being required to close a reading magnet, and the other polarity being required to open the reading magnet. Secondly, it relates to the application of a condenser to multiple telegraphs, by which means the static charge of the line may be completely neutralised, and the reversals of battery from distant station, when working multiple telegraphs, are bridged over on the home relays.

695. "Cables or conductors for telephonic or telegraphic purposes." W. R. LAKE. (A communication from C. E. Chinnock, of Brooklyn, and J. de Hart Harrison, of Newark, U.S.A.) Dated Feb. 17. 6d. The principal object is to more effectually preclude the transmission of messages from one line-wire or conductor to another in its vicinity, and thence to any but the desired destinations. Also to carry off all currents caused by escape or induction from an outside source, and thereby prevent them from interfering with the transmission of messages along the line-wires. To these ends the improvements consist in the combination with a line-wire or conductor provided with an insulating covering, and with an external electric conductor of an uninsulated conducting wire independent of the said line-wire or conductor, but in electrical communication with its external electric conductor, and in communication with the ground, whereby electric currents caused by escape or induction from an outside source are carried off to the independent conductor, and thence to the ground at any suitable points; also of various modifications of above.

699. "Apparatus for preventing the injurious effect of induced or escaping electrical currents in telephonic or telegraphic lines." W. R. LAKE. (A communication from C. E. Chinnock, of Brooklyn, and J. de Hart Harrison, of Newark, U.S.A.) Dated Feb. 17. 6d. Comprises the combination of insulators sustaining the conductors, and supports therefor, in electrical communication with each other through a guard or other wire or wires in common to said supports, and in communication with the ground, whereby in a simple manner provision is made for carrying off escaping or induced currents at various points.

725. "Distributing currents for electric lamps or candles." J. IMRAY. (A communication from La Société Générale d'Electricité, Paris.) Dated Feb. 18. 6d. Relates to an arrangement of disconnecting and commutating apparatus, such that if one of a number of lamps should be extinguished or its carbons be consumed, this lamp is automatically thrown out of circuit and the next is brought into circuit, and consists of a strip of metal in U form inverted, which the heat causes to unbend and brings in contact with a screw; also in a commutator for bringing the candles successively into circuit.

751. "Telegraph wires." F. J. CHEESEBOROUGH. (A communication from A. K. Eaton, of Brooklyn, U.S.A.) Dated Feb. 20. 6d. Consists of a telegraph wire incased in a lead tube, and covered with a spongy coating, such as asbestos or mineral wool, between the sheathing and the wire, and filled or consolidated with an insulating material introduced in the spongy coating in a fluid or liquid state obtained by heat; also in a special process for incasing and insulating the said wire.

City Notes.

Old Broad Street, September 28th, 1880.

DIRECT SPANISH TELEGRAPH COMPANY, LIMITED.—The report of the directors for the half-year ending 30th June, 1880, to be presented at the general meeting of shareholders, to be held on Thursday, the 30th September, 1880, states that the accounts for half-year ending 30th June, 1880, show a balance to the credit of profit and loss account of £3,559 13s. 3d. As the Bilbao cable was interrupted during the first 2½ months of the half-year, the traffic receipts (£5,573 17s. 11d.) may be considered satisfactory. The cables of the Company continue to work perfectly, and their electrical

condition is as high as ever. In consequence of arrangements with the postal telegraphs, it has been decided to exchange traffic with the department at Falmouth, instead of at the Lizard, and an underground line is being constructed by the Company between these two points. This work is being executed at a comparatively small cost, as some cable recovered from the Bay of Biscay last year, and suitable for this purpose, is being utilised. As will be seen by the accounts, the cost of repairing the Bilbao cable was £5,209 13s. 3d., and has necessitated the withdrawal of £759 10s. 10d. from the reserve fund. The accumulated dividends on the preference shares up to 30th June amount to 20s. per share. The balance of £3,559 13s. 3d. at the credit of profit and loss enables the directors to recommend that 10s. per share thereof be paid, and that £638 3s. 3d. be added to the reserve fund, which will then amount to £2,078 12s. 5d. The next remittance from the Spanish Government for the June quarter is expected at the beginning of November, when the dividend warrants will be issued to the preference shareholders.

The Eastern Extension Telegraph Company notify that the accounts of the Company to the 30th June last show (subject to audit) a balance of profit of £95,535 for the half-year, out of which the board have already paid one interim dividend of 2s. 6d. per share, and they have this day declared another of a like amount for the quarter ending June 30th, together with a bonus of 1s. per share, payable on the 15th of October, making a total payment of 3 per cent. for the half-year. A balance of £35,610 is carried forward.

Mr. C. M. Hooper, the Secretary of the W. I. and P. Telegraph Company, writes to us, under date August 31, as follows:—In consequence of the unusually numerous interruptions to the cables of the West India and Panama Telegraph Company, their ship permanently stationed in the West Indies has been unable to overtake the repairs, and the directors have, consequently, found it necessary to send out a second ship to assist. The new ship will sail in about five weeks, on the completion of the necessary alterations and fittings, and will take out with her a further supply of new sheathed cable.

An arrangement has now been arrived at between the Anglo-American, the Direct, and the Compagnie Française. The tariff from October 1st is to be the same for all, namely 2s. per word. The two first named Companies are to take 84 per cent. of the total receipts of the three, and the new Company is to have the remaining 16 per cent. as its share. There will be special rates for press messages.

The following are the final quotations of telegraphs:—Anglo-American Limited, 64¼-64¾; Ditto, Preferred, 95¼-95¾; Ditto, Deferred, 35¼-35¾; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9⅜-9⅝; Cuba, Limited, 9¼-9¾; Cuba, Limited, 10 per cent. Preference, 16¼-16¾; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11¾-12¼; Direct United States Cable, Limited, 1877, 12½-12¾; Scrip of Debentures, 103-105; Eastern, Limited, 9¾-10; Eastern 6 per cent. Preference, 12⅜-12⅝; Eastern, 6 per cent. Debentures, repayable October, 1883, 106-109; Eastern 5 per cent. Debentures, repayable August, 1887, 103-106; Eastern, 5 per cent., repayable Aug., 1899, 103-106; Eastern Extension, Australasian and China, Limited, 9⅞-10⅛; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 104-106; Ditto, registered, repayable 1900, 105-107; Ditto, 5 per cent. Debenture, 1890, 102-104; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 102-104; Ditto, ditto, to bearer, 102-104; German Union Telegraph and Trust, 9¼-9¾; Globe Telegraph and Trust, Limited, 6⅜-6⅝; Globe, 6 per cent. Preference, 12⅜-12⅝; Great Northern, 9⅞-10⅛; Indo-European, Limited, 25-26; London Platino-Brazilian, Limited, 4⅞-5; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 10-11; Submarine, 240-250; Submarine Scrip, 2¼-2½; West Coast of America, Limited, 2⅜-2⅝; West India and Panama, Limited, 1⅜-1⅝; Ditto, 6 per cent. First Preference, 6¾-7¼; Ditto, ditto, Second Preference, 6½-7; Western and Brazilian, Limited, 7¼-7½; Ditto, 6 per cent. Debentures "A," ——; Ditto, ditto, ditto, "B," 96-99; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 101-103; Telegraph Construction and Maintenance, Limited, 34¾-35¼; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3⅜-3⅝; India Rubber Company, 15½-16; Ditto 6 per cent. Debenture, 105-107.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
August, 1880 ...	*	a 10,417	2,000	1,197	*	42,988	30,249	22,800	... ...	*	... ...	a 8,612	1,792
August, 1879 ...	51,300	a 9,880	2,557	996	17,100	36,257	26,242	16,800	... ...	10,789	... ...	11,113	3,877
Increase	... ...	537	... ...	201	... ...	6,731	4,007	6,000	... ...	... ...	... ...	... ...	... ...
Decrease	... ...	... ...	557	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	2,501	2,085

* Publication of receipts temporarily suspended. a Four weeks.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

Vol. VIII.—No. 185.

ELECTRIC MOTORS.

The problem of the electrical transmission of power to a distance has given a considerable impetus to the invention of electric motors. The interchangeability of the electric generator and the electric motor is generally known to be possible; indeed, in almost all the experiments made on a large scale to show the possibility of the electric transmission of power, the motor and generator have been identical in construction. It seems to be admitted, however, that in several points the motor should differ from the generator, if the highest percentage of efficiency is to be obtained. In other words, the best generator does not necessarily form the best motor.

The tendency, in most cases, is to go back to the forms of motors which were designed plentifully many years ago. The motors of Trouvé, Wiesendanger, and others—the peculiar feature of which consists in the shaping of the armatures and inductors in such a way that the approach of the two together is gradual—were anticipated at least thirty years ago by the late Sir Charles Wheatstone, who invented and constructed several machines on the principle. These, we believe, may be seen in the museum of King's College, London, amongst the collection of that prolific inventor.

That there is a good field for invention in the direction of electric motors, can hardly admit of doubt, as their employment is likely to be considerable at no very distant date. At present the experiments made have been but fitful, though we believe that many are working quietly at the subject.

Electro-Magnetic Machines.—A paper was recently read before the Academy of Sciences on the law of electro-magnetic machines, by M. Joubert. With a given intensity of field, whatever the other conditions in which the machine works, from the moment when it gives maximum work the retardation is equal to one-eighth of the entire period; the intensity is constant and equal to the quotient by $\sqrt{2}$ of the absolute maximum of intensity; the electro-magnetic work is proportional to the velocity; and the velocity is in a constant ratio to the resistance.

ON THE NUMBER OF ELECTRO-STATIC UNITS IN THE ELECTRO-MAGNETIC UNIT.

By R. Shidar, M.E., Imperial College of Engineering, Tokio, Japan.

Read before the British Association, August, 1880.

The object of the paper is to describe experiments made during the month of July last in the Physical Laboratory of the University of Glasgow for an evaluation of "v," the number of electro-static units in the electro-magnetic units of absolute electrical measurement. We can evaluate "v" by determining the common electro-static and electro-magnetic measure of any of the following data: electro-motive force, current, quantity, resistance, and capacity. In the experiments described below the first of these data for one of Sir William Thomson's gravity Daniells was measured both electro-statically and electro-magnetically. The method of experimenting was as follows:—

(I.) Absolute electro-static measurement of the electro-motive force.

This measurement was made by means of Sir William Thomson's absolute electrometer. It is not easy to explain shortly how the electro-static measurement is made by this instrument; but briefly speaking it is as follows: Imagine a circular disc suspended by springs in a horizontal plane inside the aperture of another larger plate in the same plane, with a continuous plate below and parallel to them.

The force of electrical attraction of the continuous plate on the disc is compared with the gravitating force of a known weight. To effect this, any electrical influence having been entirely removed, a known weight is put on the disc, which is then raised by means of a micrometer screw until it comes to its original position; and then the weight is taken away, allowing electrical force to act when the continuous plate is adjusted by the aid of another micrometer screw, to bring the disc to the same position as before. A full account of the instrument will be found in Sir William Thomson's Report on Electrometers, "British Association Report," 1867, and republished along with his other papers on Electro-statics and Magnetism.

The E. M. F. of a battery consisting of 30 Daniell cells was measured by connecting first one pole to the continuous plate, the other pole being connected to the outside of the jar of the electrometer when a reading is taken, and then reversing the poles when another reading is taken. Very careful and repeated observations gave for the difference of the two readings, 13·495 micrometer divisions, when the attracting force is equivalent to that of ·5 grammes.

As to the mathematical calculation we have—

$$\text{v} - \text{v}^1 = 2\,(\text{D} - \text{D}^1)\sqrt{\frac{\text{F}}{\text{R}_1{}^2 + \text{R}_2{}^2}}$$

where $\text{v}-\text{v}^1$ = E. M. F. of the battery.

$\text{D}-\text{D}^1$ = difference of distances in c. m. between the disc and the continuous plate corresponding to the readings of the opposite poles.

F = attracting force (C. G. S.) of continuous plate on the disc.

R_1 and R_2 = radii in c. m. of the disc and the aperture respectively.

Hence we get, $\text{D} - \text{D}^1$ being $= 13{\cdot}495 \times \dfrac{5}{10{,}000}$, $\text{F} = {\cdot}5 \times 981{\cdot}4$, $\text{R}_1 = 2{\cdot}3$, $\text{R}_2 = 2{\cdot}375$, $\text{v} - \text{v}^1 = {\cdot}904187$ (C. G. S.).

The E. M. F. e of the gravity Daniell was compared

by means of a Thomson quadrant electrometer before and after the above experiment with that of the battery, and was found to be $\frac{V - V^1}{26{\cdot}299}$, or $e = {\cdot}0034381$ (C. G. S.).

(II.) Absolute electro-magnetic measurement of the electro-motive force.

The E. M. F. of Thomson gravity Daniell, just measured electro-statically, was measured electro-magnetically by determining, by means of a tangent galvanometer, the strength of the current which it produces in a circuit of known resistance.

The tangent galvanometer that was employed consists of a circular coil of mean radius 18·2 c. m., containing 400 turns in 19 layers of insulated copper wire, the breadth and the depth of the coil being 2 and 1·3 c. m. respectively. The needle of the galvanometer consists of a magnet about $\frac{1}{2}$ c. m. long only, made of hard tempered steel wire, and suspended in the centre of the coil by a single silk fibre. To the needle is attached a very fine straight glass fibre, of such a length that its ends travel round the graduated dial of radius a little less than that of the coil, thus serving for taking readings.

The mathematical theory shows that in a tangent galvanometer—

$$C = \frac{H \tan a}{2 \pi n} \sqrt{r_0^2 + b^2} \times \frac{3 q^2 r_0^2}{3 q^2 r_0^2 + d^2 (q^2 - 1)} \dots \text{(A)}$$

where C = current strength; H = horizontal component of earth magnetism; a = angle of deflection of galvanometer needle; n = number of turns of wire in the coil; b = mean radius of the coil; q = number of layers of wire; r_0 = half the breadth of the coil; d = half the depth of the coil.

If now E be the E. M. F. in the electro-magnetic units, R the resistance of the circuit, we get—

$$E = \frac{R \tan a \, H}{2 \pi n} \sqrt{r_0^2 + b^2} \times \frac{3 q^2 r_0^2}{3 q^2 r_0^2 + d^2 (q^2 - 1)} \text{ (B).}$$

The equation (B) tells us that whatever be the value of the resistance R, the product R $\tan a$ is a constant quantity as long as E is kept constant, which presents itself this important suggestion, that by varying R we also vary a, and thus we can get many values very nearly if not exactly equal of the product, the mean of which should be the more accurate value of the product. With this view the current from the gravity cell was passed through the galvanometer, and a variable resistance when the deflection of the needle of the galvanometer was read. The object of introducing the variable resistance is twofold; (1) to enable us to alter the whole resistance R, and (2) to obtain the more advantageous deflections. It can be shown mathematically that the more sensitive the tangent galvanometer is the nearer the angle of deflection is to 45°.*

The resistance of the galvanometer was measured by the Wheatstone bridge method. The resistance of the cell was measured by taking readings on the scale of Thomson quadrant electrometer connecting the poles of the cell to the electrodes of the electrometer, first when the poles are unshunted, and secondly when they are shunted by a known resistance; the resistance of the cell in this case is equal to the product of the difference of the two readings into the shunt divided by the second readings.

The values of R $\tan a$ obtained in the way above described agreed very closely, the mean of all being $104{\cdot}73 \times 10^9$.

The method of determining H consisted (1) in observing the period of vibration of a magnet under the horizontal force of the earth magnetism, and (2) in the deflection of the needle of a magnetometer placed in the magnetic meridian by the action of the magnet placed at a certain distance from it in a horizontal line passing through the centre of the needle of the magnetometer at right angles to the meridian. Two different magnets, made out of hard-tempered steel wire, about ·1 c.m. in diameter and 5 c. m. long, were experimented upon; experiments were also made by altering the distance of the magnet from the magnetometer. The results obtained in all cases agreed closely, and the mean value of all was—

$$H = {\cdot}15947.$$

It can be easily shown that—

$$H = \frac{2 \pi}{t (k - e)(k + e)} \sqrt{\frac{2 k i}{\tan d}}$$

where t = period of vibration of magnet under H.
k = distance of centre of magnet from the centre of needle.
e = vertical half-length of the magnet.
i = moment of inertia of magnet round an axis through its centre at right angles to its length.
d = deflection of needle in degrees.

Now the equation (B) gives—

$$E = 1{\cdot}001172 \text{ (C. G. S.)}$$

Hence $v = 294{\cdot}4 \times 10^8$ centimetres per second.

In conclusion, it might be mentioned that although great care was taken in making the experiments, yet as it was only once that the complete measurements were gone through, there might have been some cause or causes of error unnoticed, as is sometimes the case. The author, therefore, intends to repeat the experiments shortly with still greater care, and hopes to be able to make a better communication soon. It must also be remembered that the value of the ohm B. A. unit of resistance was assumed to be correct, though there is doubt as to the correctness of the value, as has been pointed out by Professor Adams, the president of the section A, in his address.

* ...hic *Journal*, July 1st, 1877, page 145. ED. T. J.]

AN ACCOUNT OF EXPERIMENTS IN PHOTO-ELECTRICITY.

By G. M. MINCHIN, M.A., Professor of Applied Mathematics in the Royal Indian Engineering College, Cooper's Hill.

(Read before the British Association, Aug. 1880.)

(*Continued from page* 326.)

18. CASE OF INVERSE CURRENTS.—Several experiments, made at various times, led me to conclude that when eosine is in the cell, and not on the plate, the photo-electric current is in the direction opposite to that of the current produced when the eosine is on the plate and not in the cell. The observed phenomena were not, however, marked enough to prove this decisively; and, indeed, the difficulty of determining the point is obvious, because if a clean plate is dipped into a cell containing a solution of eosine, the plate will at once take up a layer of eosine, however thin, and we shall necessarily have the two cases combined.

An experiment which seems to me to have a bearing on this question is the following:—I took a large glass cell and filled it with distilled water containing a very small quantity of eosine. The liquid became brilliantly coloured. The cell was completely covered over with black paper pasted to the faces, with the exception of a rectangular strip of one face, opposite to which was placed the plate on which the light was to fall. Two clean silver plates were immersed in the cell, and con-

nected with the galvanometer in a lower room. The cell was at the top of the house, and the light used was sunlight. No light being admitted, the D. C. happened to be from the shaded place to that which was about to be exposed, and after five minutes this current had so far died out that the spot came to rest at 40 divisions from its zero position.

Now, when the screen in front of the cell was suddenly removed, the spot moved over 80 or 90 divisions of the scale *in the direction opposite to that in which it was moved by the D. C.*, and after this initial deflection it moved steadily in the opposite direction, just as it would have moved if the plate had been coated with an eosine-gelatine film, and its motions then appeared to answer the variations of light intensity as usual. This latter (or normal) motion was much greater than the initial impulsive motion.

Again, when the screen was suddenly replaced in front of the cell, the spot, instead of going suddenly back towards the zero position (as we should expect it to do on the withdrawal of the light) *took an impulsive forward motion over* 80 *or* 90 *divisions of the scale*, after which it moved backward to zero.

The same experiment was tried with fluorescine—a different cell being, of course, used. The same results were observed, except that the impulsive motions of the spot took place over only 4 or 5 divisions instead of 80 or 90.

It would seem to me that these observations are consistent with the supposition that the action of light on eosine and fluorescine is a cause of the production of electric currents, quite apart from those which it may generate by effecting chemical action between these bodies and metallic plates.

19. NAPHTHALINE RED.—A silver plate was coated with a layer of gelatine, which was shaken up in a test-tube with a very small quantity of naphthaline red, this latter having been previously dissolved in alcohol. The layer was allowed to set thoroughly on the plate, and, when immersed in a cell containing tap water, no discoloration of the water took place, however long the plate was left immersed.

Apparently, for photometric purposes, this is the best plate that I have found. A naphthaline red plate which was made last April, and which has been used several times since, gives results now which are at least as good as those given by it originally.

With these plates the currents are not quite so strong as those given by eosine plates. Moreover, some experiments with coloured glasses show that currents in opposite directions are produced by the red and the blue rays.

I quote the records of two experiments:—

June 28.—Naphthaline red. D. C. from U. to S. in cell. Spot steady at 30 divisions to right of zero. Sunlight.

No glass	in front	of cell.	Motion	of spot	to	200,	left	(opposite to D.C.) from	30,	right.
Blue	„	„	„	„	„	180,	„	„	10	„
Violet	„	„	„	„	„	0,	„	„	10	„
Red	„	„	„	„	„	20,	right,	„	30	„
Yellow	„	„	„	„	„	„	„	„	„	„
Green	„	„	„	„	„	„	„	„	„	„

[The opposite results of the red and blue rays do not appear in this experiment; but this may be due to the comparative smallness of the effect of the red end, and to impurities of colours in the glasses.]

June 28.—Same plate, same cell. Magnesium light. Spot steady, at 45 divisions to right of zero.

Red glass in front of cell.	Motion from 45, right, to 200, right	same direction as D. C.
Yellow, ditto	do., to 150, right	ditto
Green, ditto	do., to 18, left	(opposite to D. C.).
Blue, ditto	do., violently off screen to left	ditto
Violet, ditto	do., off screen to left.	ditto

The opposite effects of the coloured glasses were observed only when magnesium light was used. With sunlight, these opposite effects were not produced in any experiments of which I have records.

With the plate prepared nearly three months previously, I observed that the D. C. usually disappeared in about one minute after the completion of the circuit; and that on the withdrawal of the light the spot returned to its zero position in about a minute.

As a general rule, I have observed that for the production of a sensitive plate a *very small* quantity of the colouring substance (eosine, napthaline red, &c.) must be used in the gelatine layer.

The use of napthaline red (in virtue of its comparative insolubility in water) was suggested to me by Mr. Wilson, of South Kensington.

20. IODINE GREEN.—In examining the photo-electric qualities of the Aniline Dyes, I found that very strong currents are produced by the action of light on a silver plate coated with iodine green and collodion. Dissolve a very small quantity of iodine green in water or alcohol, pour it in a *thin* layer over the plate, and when the plate has become thoroughly dry, pour over it a layer of collodion. Then dip it a few times in a tumbler of water. After the first dip a little of the iodine green will come into the water—probably from the edges of the plate; but subsequently no visible amount will come off.

Placed, in the usual way, in a cell containing tap water, it gave a strong D. C., which died out completely in about twenty-four hours.

Strong sunlight gave a current

from U. to S. in the cell,

and this current kept the needle tight against the stops. In order to bring the spot back to the edge of the scale, it was necessary to place three blue glasses and a violet one in front of the cell.

21. MEASUREMENT OF THE E. M. F.—Twelve of the small ebonite cells with blue glass faces were employed for the measurement of the E. M. F., produced by the action of sunlight on a silver plate coated as above with iodine green. Exposed to very oblique sunlight in a window of the Physical Laboratory at University College, London, the poles of the battery were connected with a Thomson Quadrant Electrometer. The deflection varied with the intensity of the light; it did not wholly disappear when the light was withdrawn; but when the circuit of the battery was closed for five minutes, there was no deflection. The D. C. had previously been allowed to disappear by closing the circuit of the battery, and leaving it in the dark during the previous night. In this observation the maximum E. M. F. (of a single cell) observed was about the $\frac{1}{72}$nd of the E. M. F. of a Daniell's cell.

The battery was left covered up in charge of Mr. Grant, the Assistant, and he kindly made further measurements whenever better conditions of sunlight offered. The sunlight in one of his observations brought up the E. M. F. to $\frac{1}{20}$th of that of a Daniell.

22. OTHER SUBSTANCES.—Although I have now described the most striking of the results obtained, several other substances have been used. Foremost among them I may mention Fuchsine, an exceedingly unstable body, a trial of which was recommended to me by Professor E. Wiedemann. The ease with which it is soluble in water renders it objectionable for coating a plate. But when mixed with photographic gelatine, which is then dipped into a solution of alum, it remains pretty well on the plate (silver), and gives good currents by the action of sunlight.

Fluorescine, used like eosine, with silver or platinum plates, gives poor results.

Of course the action of light on a silver plate, coated

simply with a layer of photographic gelatine, rendered insoluble by alum solution, was separately investigated. Exposed to sunlight the result was scarcely perceptible.

Sulphate of quinine has not yielded any marked result, but it remains for further trial.

ON A PECULIAR BEHAVIOUR OF COPPER.

By W. H. PREECE.

(Read before the British Association at Swansea, August, 1880.)

In the preliminary experiments with the copper conductor, made by Dr. De la Rue and myself, to get everything in working order, it was noticed that in each case the effect of the first discharge was considerably smaller than in the subsequent ones, leading to the conclusion that the resistance of the conductors was affected by the powerful currents sent through them. The difference was so marked that no variation in the electromotive force of the battery or in the capacity of the condenser would account for it. Moreover, all the connections were so carefully made that nothing could account for the change but a variation in the resistance of the conductors.

Experiment 1.—A piece of ordinary gutta-percha covered wire, 30 feet long, was first used as a shunt to the galvanometer. A delicate Thomson's reflecting galvanometer (whose resistance was 5270ω), was joined up in circuit with a single cell of a battery, and a resistance of 100ω. Discharges were then sent through the wire, and the latter, after each discharge, connected to the galvanometer. No difference was observed in the readings taken before and after the discharges. Any alteration in the resistance, however minute, would have been visible in the readings of the galvanometer. The wire had been used for other purposes, and weak currents had been through it before. Hence it was thought that the effect might be evident only in virgin copper, that is, copper through which no current had previously passed.

To test this, three pieces of virgin copper wire—0·029, 0·049, 0·071 inches diameter—were obtained direct from the manufacturers, and used as shunt to the galvanometer previous to and after conveying the powerful currents resulting from the discharge of 42·8 mf., charged by 3280 cells.

Experiment 2.—0·071-inch wire—

Previous to discharge	210°
After first discharge	210
„ second „	173
„ third „	153
„ fourth „	150

The change was very marked.

Experiment 3.—0·049 inch wire—

Previous to discharge	440°
After first discharge	440
„ second „	440
„ third „	440
„ fourth „	440

No change was observed.

Experiment 4.—0·029 inch wire (200ω resistance in circuit)—

Previous to discharge	630°
After first discharge	630
„ second „	615
„ third „	615
„ fourth „	610

Change was very slight.

Experiment 5.—The same experiments were performed with lead conductors, but without perceiving any change. Hence, while a considerable change of resistance was observable, the effect was very variable. The fact, however, is evident, that in some cases copper wire does not acquire its normal resistance until currents have passed through it. No definite conclusion or measurable results can be obtained from these experiments. Nevertheless, the phenomena were so decided and peculiar, that Dr. De la Rue and I propose to pursue the inquiry when foreign travel and seaside rest have restored our waning energies and replenished our scientific ardour.

ELECTRIC CONVECTION-CURRENTS.

By SILVANUS P. THOMPSON, D.Sc., B.A., Professor of Experimental Physics in University College, Bristol.

(Read before the British Association at Swansea, August, 1880.)

In a paper, "On the action of Magnets on Mobile Conductors of Currents," read before this section a year ago, the author discussed a number of cases of the flow of electricity across a magnetic field. These included cases of true metallic conduction, of electrolytic conduction, and of those less understood kinds of conductivity, which occur in the voltaic arc, in the discharges in rarefied media, and in the luminous brush-discharge at a point. For the case of the convection of electricity either automatically, by self-repulsion between electrified particles of a gas, or mechanically, the electro-magnetic effect is identical with that of a current in which the same quantity of electricity would be transferred in the same time, the "rate of convection" $\frac{\delta Q}{\delta t}$ being, in these cases, the equivalent of "the strength of the current."

Maxwell's theory (Vol. II., Art. 768) concerning the virtual identity of a current sheet and of an electrified sheet moving in its own plane, with a velocity equal to "V," may be extended to the case of linear currents. The identity may be generalised to all cases of convection-currents.

Last year the author predicted that the brush-discharge at a point would experience a spiral twist when taking place in the magnetic field. He has since found this to be experimentally the case.

The author also pointed out the similarity between the magnetic distortion found by Reitlinger and Wächter, in electric ring-figures, and that found by himself, to be produced by the presence of a magnet on Nobili's figures. He also referred to Maxwell's theory as explaining some of the phenomena observed in the exhausted tubes of Mr. Crookes, in which the discharge from the negative electrode behave like convection-currents, having a velocity less than the velocity of light.

MAJOR MACGREGOR'S EKOWE POCKET HELIOGRAPH.

A VERY handy and portable form of heliograph has recently been designed by Major Macgregor, of the 29th Regiment. The inventor was led to consider the subject from the success which attended his efforts to communicate, by means of sun-signalling, from Fort Ekowe to the Tugela, in Zululand, last year. The means then at hand consisted only of a looking-glass, in the possession of an officer's servant, which, by suitable arrangement, did the work very well over about 27 miles of country.

From Ekowe, over a distance of 10 miles, Major Macgregor sent messages by means of a shaving glass, held in one hand, shutting off the sun with the skirt of his coat in the other.

C, are unscrewed. The two mirrors lie face to face, and the legs and upright of stand (with sight arm folded down) lie parallel to one another, the whole fitting into a leather case 13 inches long, 3½ inches wide, and 1½ inch deep. The instrument weighs two pounds.

The instrument is used in the following manner:—

When the sun, S, is in front—that is, towards the distant station, the heliograph is set up with the sight vane (enlarged sketch seen to the right of fig. 1) in the general direction of the distant station, and the mirror facing in the same direction (as shown by fig. 1).

The eye is then placed as close as convenient to the back of the mirror, and the latter looked through at the centre hole; at the same the V of the sight vane, E, is set in line with the distant station.

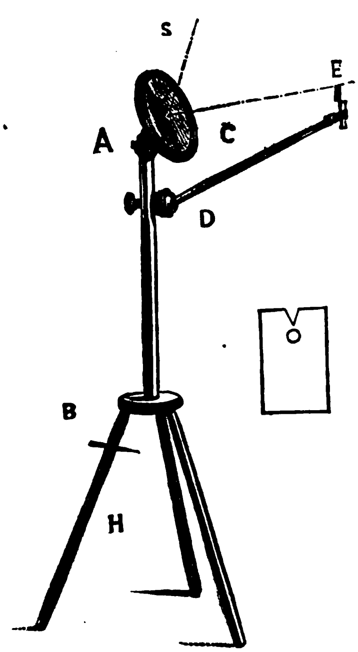


FIG. 1.

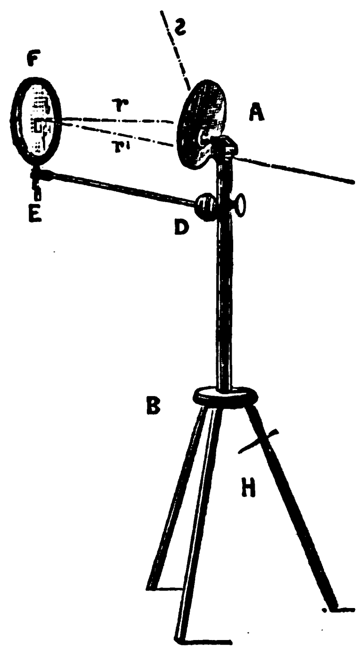


FIG. 2.

The present instrument is extremely portable, cheap, and not liable to get out of order.

The following is a description of the apparatus :—

A B is a metal stand; H, H, H, three legs screwed into base, B; A, a ball and socket, carrying a very short arm, to which is fixed a circular mirror, C, 3 inches diameter, having a small hole pierced through centre of the backing, and the silvering removed at that point. D E is a light arm, about 8 inches long, movable on a ball and socket at D, and clamped by a screw behind D.

F is a circular mirror similar to C, having a straight arm 2 inches long, which fits into a socket at E, the socket being movable on a hinge. The mirror, F, can be removed at pleasure, and the socket, E, turned so as to stand upright, to form a "sight vane" when the sun is in a certain position.

To pack up the instrument, the legs and mirror,

The mirror and sight arm are then so manipulated that the dark spot, cast by the unreflecting centre hole, is thrown on the bottom of the V, in the sight vane, whilst, *at the same time*, the centre hole, bottom of V, and distant station are in one straight line. Thus, the "flash" is directed on the distant station.

Signalling is carried on by using the Morse alphabet of "dots" and "dashes," which is effected simply by interposing and removing the hand, a note book, piece of board, &c., smartly between the sight vane and the surface of the mirror. By this means letters can be sent as fast as the eye can read.

In military signalling it has recently been decided to signal by obscuration instead of by flashing, which renders this instrument rather more handy than if "flashing" only were used.

When the sun is not in the direction of the

distant station, the following arrangement (shown by fig. 2) is required. The sight vane, E, is reversed, and the second mirror, F, slipped in. The instrument is then set up so that the principal mirror, A, faces the sun, S, and has its back towards the distant station.

The centre hole in mirror A is then looked through, and the mirrors manipulated until the reflection of distant station is seen within the V on the paper fixed on face of the mirror, F.

By a little practice the next movement can be made, which is to so manipulate the two mirrors that, by looking through the centre hole of A (from behind), the distant object is seen reflected within the V of the paper on F, *and, at the same time*, the dark spot from the central unreflecting portion of A is thrown on bottom of the V on F; dots and dashes are then made as in the first case.

When the sun is very hot, care must be taken to clamp the sighting arm by means of the screw behind, as otherwise, the outside cap of the ball-socket expands, and the arm falls.

It is necessary to slightly re-adjust the sighting, as the dark spot gradually moves from its proper position, due to the apparent motion of the sun.

The instrument, we may remark, is manufactured by Mr. Stone, of 44, Gloucester Street, Bloomsbury.

CANCE'S DYNAMO-ELECTRIC MACHINE.

By E. HOSPITALIER.

GOOD dynamo-electric machines actually transform 80 to 90 per cent. of the power expended in driving them, into electricity. In the face of these figures it is evident that there is but little improvement with regard to economic efficiency to be desired, but there is a good opening for improvements on the side of simplicity of construction and small first cost. It is with these objects that the machine of M. Cance has been constructed, and it appears to present certain advantages, which we will point out. The machine is composed essentially of two pairs of fixed inductors placed upon the frame, and of an inductor (represented by fig. 2) composed of 24 bobbins arranged in two series of twelve each, and connected to a Gramme commutator, seen to the left of fig. 1.

The bobbins cut the magnetic field parallel to the axis of rotation, and change their polarity twice each turn.

This arrangement is similar to a certain point with the machine of M. Niaudet (*Telegraphic Journal*, April 1st. 1876), in which the permanent inducing magnets are replaced by electro-magnets.

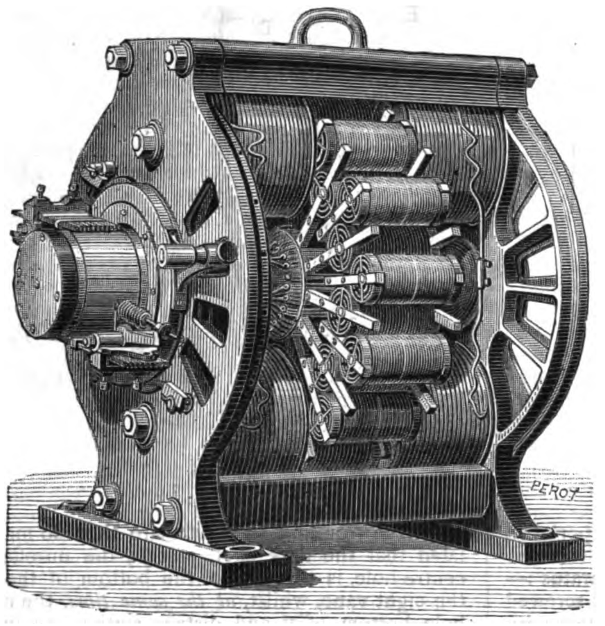


FIG. 1.

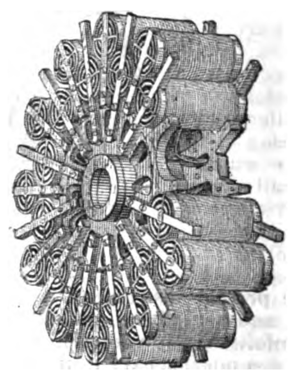


FIG. 2.

The novel idea of M. Cance consists in the employment of special bobbins and of special inductors, which augment in a great degree the power of the machine.

Each bobbin is composed of a bar of soft iron formed of a number of iron wires well annealed and very soft; on these are coiled two layers of insulated copper wire, and then a second wrapping

of iron wires of the same dimensions as those forming the core, over these again are coiled two more layers of insulated copper wire, and so on, three, four, five, or six times, according to the power of the machine.

This arrangement of the electro-magnet, which dates from 1875, and which M. Cance has applied to his machine, presents several advantages.

As regards the inductors, the turns traversed by the current being always very near to the iron layers which they magnetise, their action is very energetic, and consequently these inductors constitute a powerful magnetic field.

As regards the induced bobbins, these little layers of well annealed iron, magnetise and demagnetise with great ease, and as they are thus very close to the inducing layers, and as, on the other hand, they are induced at their two ends at a time, they combine all the conditions necessary for giving to the induced currents a great intensity, that is to say, a powerful magnetic field, rapid and easy magnetisations, and an inductive action produced at a very short distance.

In order to avoid a too great development of the crown formed by the induced coils, and the consequent considerable action of centrifugal force, M. Cance has arranged the bobbins in two concentric series of twelve bobbins each.

Under these conditions, the outside crown having a greater velocity than the inside one, the inductive actions are more energetic in the former. M. Cance has got rid of this inconvenience by increasing the surface of the magnetic field of the inside bobbins. By this arrangement, the induced currents are sensibly equal in the two series of bobbins, for what is lost by low velocity is made up for by a more intense magnetic field.

We should point out an arrangement of the brushes which allows of the instantaneous change of their position according to the velocity, and which gets rid almost completely of the extra current sparks; the collector is placed outside the frame, it is thus independent of all the other pieces, and can be easily altered or replaced. The same system allows of the easy construction of machines with alternate currents which produce powerful effects within a very small space; this is another idea of the inventor.

In an experiment at which we assisted, the machine turning at the rate of 1,100 turns per minute, a current of 25 webers was give out, measured by a Siemens and Halske dynamometer, and through a resistance formed of 200 metres of cable and a Serrin regulator, giving an arc of 3 millimetres in length with square carbons 9 millimetres thick.

These results represent, almost exactly, the results furnished by a Gramme machine, workshop type, turning with the same velocity.

The machine of M. Cance does not occupy a greater bulk, it employs the same quantity of copper and has a total weight a little less; the coiling of the bobbins, their fixing on the axle, and their replacement, is effected with the greatest ease; it can therefore be used in the place of the Gramme machine in all the applications of electricity, such as the electric light, the transmission of power, &c., if its inventor can bring it out at a low price, the sole factor which has any decisive influence in the development of the applications of electricity.—*La Lumière Electrique.*

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XIX.

A B C Instrument—(*continued*).

The Bell.

The A B C bell or alarum is in many respects an ingenious contrivance, and it is so constructed that whilst it can be rung by very weak alternate currents it cannot be set off accidentally by any jarring. Four alternate currents require to pass through the instrument before it can be set ringing.

The arrangement of the mechanism can be seen by fig. 75.

w, w_1, and w_2 is a train of three wheels, the first of which contains the main spring, which is kept wound up by a key.

The last wheel, w_2, in the train gears into a pinion, *n*, the axle of which has an arm, *t*, fixed at right angles to it. This arm would revolve continually round with the axle under the influence of the clockwork train if its end did not rest against an axle, *f*. A portion of this axle is cut away at f_1 (see small figure at side). Now in the position of *f* shown in the figure the end of the arm, *t*, rests against the uncut portion of the axle, but if the latter be rotated a little way round, then when it comes to a certain position the end of the arm, *t*, is free, since it slips through the cut away portion, f_1, of the axle, and thus the whole train of clockwork can revolve.

At the end of the axle, *f*, and outside the frame plate of the mechanism, is fixed the arm, *l*. The end of this arm has two little pins, p_1 p_2, at right angles to it. A bent piece of brass, *b*, fixed at the end of an axle running parallel to the other axles of the mechanism has also two little pins, p_3 p_4, fixed to it.

In the position of *l* and *b* shown in the figure the pin p_2 rests on the pin p_4, and thus the lever, *l*, is prevented from dropping. If now the piece *b* be rotated a little to the right, the pin p_2 will escape from pin p_4, and the lever, *l*, will drop until pin p_1 comes against pin p_3; if now the piece, *b*, be rotated back again then pin p_1 will clear pin p_3, and the lever, *l*, will drop further till pin p_1 drops on p_4; another movement of *b* frees p_1, and the lever, *l*, can drop free on to the stop pin *g*. In the position shown in the figure, pin p_4 is shown as resting on pin p_2, but actually the normal position of the arm is when pin p_4 is resting on pin p_3. There are, therefore, four backward and forward movements of the piece, *b*, necessary to quite free the arm, *l*, and allow it to drop, which it does by its own weight.

When the drop takes place, as previously explained, the arm, *t*, is free to turn, and the clockwork train can run.

On the end of the axle of the wheel, w_2, and outside of the back frame plate, is fixed the ratchet wheel, *s* (see right-hand figure). Loose on the axle referred to, turns the double-armed lever, *e e*. The arms of this lever have springs, *d* d_1, fixed to them, the ends of which hitch into the teeth of the

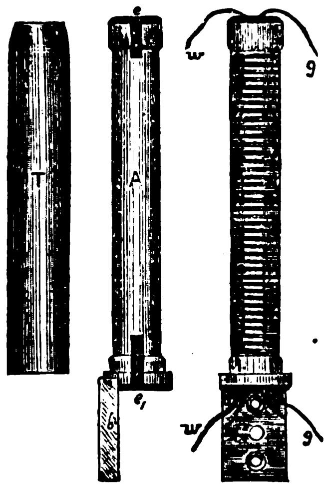

T
A
e
e_1
b
w
g

FIG. 76.

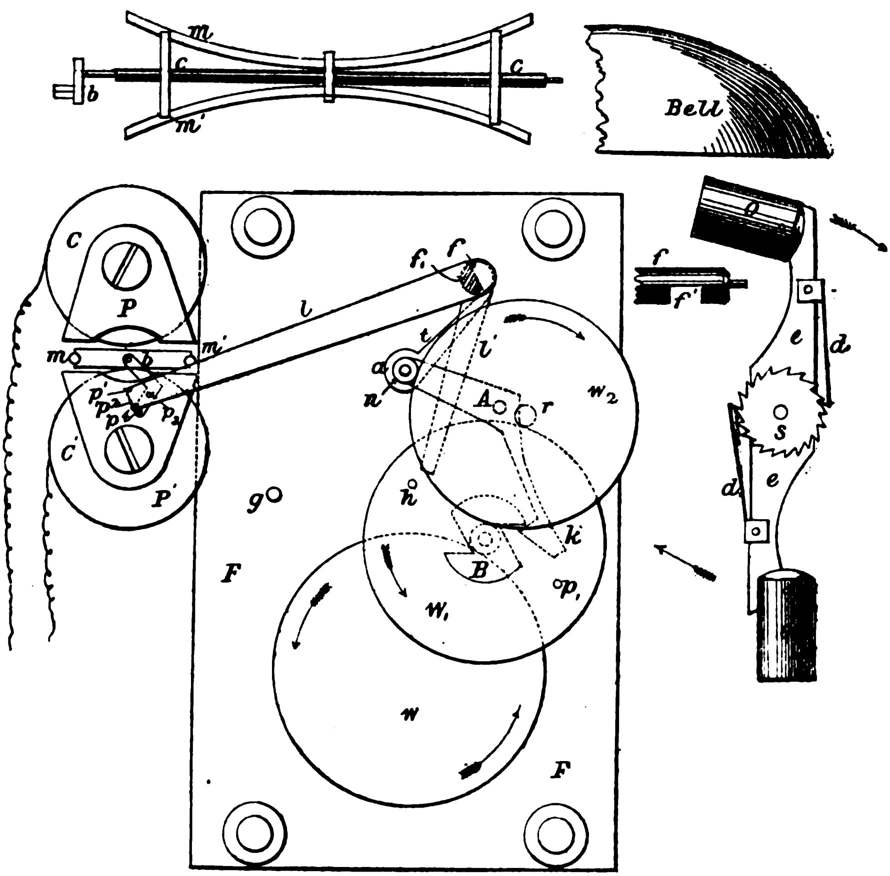

m
m'
c
c
b
Bell
C
C'
P
P'
l
f
f_1
t
a
n
A
r
w_2
l'
g
h
k
B
p_1
w_1
w
F
F
Q
f
f'
e
d
s
d
e

FIG. 75.

ratchet wheel, *s*. Thus if the latter be rotated it catches hold of the springs and rotates the arms, *e e*, with it, and immediately the rotation of *s* is stopped, then the arms, *e e*, can go on rotating until their impulsive action is expended.

At the ends of the arms small weights, *o o*, are hinged which fly out by centrifugal action and strike the bell dome immediately over them.

We thus see that the release of the arm, *l*, allows the clockwork mechanism to be freed and the bell to be rung.

The movement of the piece, *b*, is effected by the permanent steel magnets, *m m*, fixed on a kind of frame on the axle, *c* (see upper figure). The poles of these steel magnets play between the pole pieces, P_1 P_1, of the electro-magnets, C C_1, which are exactly similar in construction to those in the A B C indicator. On sending alternate currents through the coils the magnets rock backwards and forwards on their axes.

This arrangement of magnets was formerly adopted in the A B C indicators, but was abandoned some few years ago as they were found to lose their magnetism and become weak in their action; this, however, is not of so much consequence in the Bell, as the magnets have practically little or no work to do, and their use has therefore been continued.

As soon as the bell has rung for a short time it has to be stopped by the arm, *l*, being lifted back in position. This is effected by pins *p* and p_1 fixed on the wheel, W_1. One or other of these pins, as the wheel revolves, comes in contact with the arm, l_1, which is fixed to the axle, *f*, and by pressing it to the left raises the arm, *l*.

Now as the arm, *l*, rises, it must be evident that before it arrives at the position where it locks against the pins on the piece, *b*, the axle, *f*, will have turned to the position where the arm, *t*, on the axle, *a*, has its motion of rotation arrested. This would stop the motion of the clockwork train, and would leave the arm, *l*, only half raised to its normal position.

To get over this difficulty, the following ingenious device is adopted:—The end of the axle at which the arm, *t*, is fixed is not pivotted into the frame plate but turns in end of the bent lever, A K, which is hinged at A. Now if the end, K, of this lever be moved to the right, the end of the axle to which the arm, *d*, is fixed will be lowered, and consequently, although the arm, *l*, may have been raised to its normal position and the cut away portion, f_1, of the axle, *f*, be brought into position, yet the arm, *t*, can continue to revolve without hinderance.

On the axle of the wheel, W_1, is fixed the small disc, B, which has two portions cut away, into either of which the end, K, of the lever, A, can drop under the influence of a spring. In the normal position of the whole mechanism the end, K, lies in one of these hollows, consequently the end of the axle, *a*, is raised, and the motion of rotation of the arm, *t*, would be arrested by the axle, *f*. Directly, however, the arm, *l*, drops and the wheels begin to turn, the disc, B, revolves, and when it has turned a quarter circle it pushes the end, K, out and lowers the end of the axle, *a*. This will continue until the disc, B, has completed another quarter circle and allowed K to again drop into one of the hollows; this, however, does not occur until one of the pins on the wheel, W_1, has caused the lever, *l*, to be completely lifted up, and until the lifting pin has passed free of the lever, l_1.

The pins, p_1 p_2, at the end of the lever, *l*, have their upper surfaces filed wedge-shaped; also the lower surfaces of pins, p_3 p_3, on the piece, *b*, are similarly formed, so that when the lever, *l*, rises it can push past the pins on *b*, freely, though on being dropped down on them (when the pin on wheel, W_1, becomes free from the tail, l_1) they cannot pass them.

The pinion on the axle on which the arm, *t*, is fixed is at the extreme end of the axle, so that the slight lowering of the other end by the bent lever, A, does not interfere with its continuing to gear properly with the wheel, W_2.

The coils of the electro-magnets are wound to a resistance of 250 ohms.

Lightning Protectors.

In order to prevent damage by lightning as far as possible, every instrument is now fitted with a lightning protector. The one in most general use is that shown by fig. 76, drawn to half scale. It consists of a brass cylinder, A, with ebonite ends, *e*, *e*, fitted to it. Through these ends two double-silk covered copper wires pass, and are wound side by side along the whole length of the brass cylinder, as shown by the right-hand figure. One of these wires, *g*, is covered with green silk, and the other *w*, with white silk, so as to distinguish the two. The whole is covered with a brass tube, T, which fits on closely to the brass collars at the end of the brass cylinder. An angle piece, *b*, enables the whole arrangement to be secured to the instrument in which it is fixed. The brass case of the protector is connected to earth, thus the two coiled wires lie in close proximity to a double earth-surface, viz., that on which the wires are coiled, and the surface of the tube which covers them. As a rule, the Down line is connected to one end of the green wire, the other end of the latter then passes to one end of the coil wire of the instrument, and the other end of the latter then goes on to one end of the white wire, whilst the other end of the latter completes the connection through the rest of the apparatus. In some cases, however, in the A, B, C instrument for example, the two ends of the white wire are connected together and connected to line, and the two ends of the green wire are similarly connected and pass to the other parts of the apparatus. In any case, however, the function of the instrument is to open an alternative route for the lightning direct from the Up to the Down line, by giving it the chance of jumping from the green wire to the white through the silk covering, or from either wire to the brass casing, and thence to earth.

Errata.—Page 335 (Oct. 1st), *for* "The communicator coils are wound to a resistance of 500 ohms, and the receiver coils to a resistance of 150 ohms," *read* "The communicator coils are wound to a resistance of 800 ohms, and the receiver coils to a resistance of 250 ohms."

ELECTRIC LIGHT EXHIBITION, GLASGOW.

An exhibition of apparatus for the utilisation of gas, electricity, oils, &c., and of hydraulic, architectural, mining, and sanitary appliances, was opened on the 28th September in the Burnbank Drill Hall and Grounds, Glasgow. The exhibition will last until the 25th of the present month. The number of exhibitors is 197, and they are from all parts of the country, though the Scottish firms are naturally in the great majority. The ingenuity expended in gas machinery and appliances is very evident from the number and variety of the exhibits in this branch of practical science. Gas apparatus for cooking purposes is strongly represented; possibly the recent electric light scare may have stimulated inventors in this direction.

Electric light appliances hardly muster in so strong an array as might have been expected, one or two large firms being conspicuous by their absence.

Messrs. P. Watt & Son, of Glasgow, exhibit two dynamo-machines driven by an 8 horse-power gas engine, and also two Mackenzie patent lamps.

Mr. R. E. Crompton, of Chelmsford, exhibits a dynamo-machine and three of Crompton's patent lamps of different patterns, also appliances for measuring the current strength developed in the circuit.

Messrs. Latimer-Clark, Muirhead & Co., as the engineers to the Electric Generator and Light Company ("Lontin" light), are exhibiting very successfully; and at the time of writing these remarks we find that the Anglo-American Electric Light Company have come upon the ground with the intention of working sixteen "Brush" lights from a single "Brush" dynamo-electric machine.

Messrs. Johnson & Phillips exhibit one of Brockie's so-called "Periodical" lamps.

Mr. Killingworth Hedges, of Westminster, shows specimens of the patent iron-coated carbons of the Electric Carbon Company.

Several firms exhibit electric apparatus more or less connected with telegraphy. Thus Messrs. Field & Co., of Lambeth, show specimens of wire insulated with ozokerit. Messrs. Lennox, Lange & Co., of Glasgow, exhibit their patent electric gas lighter; Messrs. Donald, Clark & Co., of Glasgow, electro-pneumatic bells; Messrs. Thomas Smith, of Glasgow, specimens of electro-plating; Messrs. Graham, of Glasgow, electric bells, telegraph instruments, telephones, batteries, &c.; Messrs. Anderson & Munro, bells and telephones. The Silvertown Telegraph Company exhibit specimens of cables manufactured by them.

Correspondence.

Robert Ross.—Apply to E. Thornton, Public Works' Department, India Office, from whom all information on the subject may be obtained.

To the Editor of The Telegraphic Journal.

Dear Sir,—From the description in your last issue of Mr. Blyth's telephone, I find that I have been working in the same path, and have produced a telephone on exactly the same principle. I commenced my experiments about eighteen months ago, through noticing the adhesion of contacts in Siemens' make and break electric lamp; but it was not until Mr. Stroh published his experiments on the adhesion of electrical contacts that I succeeded in making the telephone reproduce speech. In point of construction, I have carried the telephone out differently to Mr. Blyth, which will be understood from the following description: Upon a spindle, mounted in bearings to revolve, are two sharp-edged discs of steel, each with a steel knife-edge resting upon it. These knife-edges are fixed to the ends of two short pieces of copper wire, the other ends of which are attached to a varnished paper membrane. Each terminal of the telephone is in connection with one of the knife-edges by a firm spiral of copper. The object of two discs and knife-edges is to make use of the contact which would be lost and cause trouble in the current passing from the bearing to the spindle. One Daniell cell is enough to reproduce speech intelligibly.

Hoping you will favour me with some of your valuable space for the above,

I am, dear Sir, yours faithfully,

J. D. F. ANDREWS.

2, Mount Street, New Charlton, S.E., 6 *Oct.*, 1880.

Notes.

Among the exhibits at the recent Dusseldorf Exhibition, the wire manufactures of Messrs. Felten and Guilleaume were conspicuous. Specimens of telegraph wire were shown to suit five specifications, amongst which was that of the English Government, the conductivity required being unusually high. There might be observed also a huge reel dressed in the colours of the Imperial German post office, and wound on this reel a length of underground telegraph cable from the Imperial German underground lines. This cable, which contains 7 conducting wires, is a specimen of the cable which is employed by the Imperial telegraph office for the large German underground lines. The conducting wire is a strand of 7 thin copper wires, insulated by a double covering of gutta-percha. Seven of these conductors are twisted into a strand and then covered with tarred jute yarn. To shield the conductors against being mechanically damaged, an armature of a number of galvanised wires is put on and then a waterproof coating of hemp and asphalte. All the telegraphic main lines of the German Empire are provided with cables of 7 conductors, and only the branch-lines have cables of 4 conductors. The telegraphic underground lines of the German Empire are to have a total length of more than 3,100 miles with altogether 19,000 miles of conductors, and they are hoped to be completed before the end of this year. By their means nearly all the principal towns of Germany are put into telegraphic communication with one another and with Berlin. The first larger underground telegraphic line was built by Messrs. Felten and Guilleaume, 4 years ago, from Berlin to Halle.

We understand that in order to meet the requirements which may be necessary in consequence of the introduction of a cheap telegram system, certain structural alterations at the head office in London are in contemplation.

Professor J. Trowbridge, in investigating with telephones connected to earth plates the flow of return

currents through "earth," found that at a mile from the Harvard College Observatory the time signals of the Observatory clock could be heard by merely tapping the earth at points 50 feet apart.

WITH the view of demonstrating the mechanical action of electrolysis, all action of heat being excluded, Signor Basso has lately experimented thus (*Il Nuovo Cim.*, ser. 3, tom. vii.). A thin square glass plate is covered with collodion, and on this when dry is put a thin layer of good gelatine, mixed with about $\frac{1}{10}$ of its weight of a saturated solution of bichromate of potash. The bare side of the plate is exposed to light, to attach the gelatine layer. Then the plate is put in an aqueous solution of chloride of gold till the upper layer is impregnated with the gold salt, and it is exposed to diffused daylight. Next the covered side is strewed with fine graphite, and the glass connected by means of four fine wires running along its sides to the negative pole of a battery. The plate is then placed in an ordinary bath of sulphate of copper. The copper is deposited regularly on the whole of it. In a few days wrinkles and bubbles appear; and if the copper has been deposited as far as the borders, the plate may at length even break, thus proving the mechanical force, which is a direct consequence of electrostriction.—*Nature.*

ANOTHER of the American telegraphic publications has run its course. In the number of the *Magnet* for September 15th, it is announced that the publication of the paper will be suspended, and that the entire editorial staff will transfer its services to the *Operator.*

THE Western Union Telegraph Company has declared its usual quarterly dividend of $1\frac{1}{2}$ per cent. Its quarterly statement shows a surplus of 332,726 dols.

IMPORTANT changes in the overland lines connecting with the Anglo-American cables have been completed. Under the new arrangements the cable facilities between America and the Old World are fully doubled, and the danger of error in transmission also greatly reduced. Bangor, U.S., will hereafter be the only repeating station between New York and the cable landing. The New York wire has been quadruplexed and will be used in connection with the new cable just landed.

PROFESSOR C. A. YOUNG, of Princeton, N. J., "On the thermo-electric electro-motive power of Fe. and Pt. in vacuo."—Eisner, a few months ago, published a paper asserting that the thermo-electric power of antimony and bismuth is destroyed by removing them from all contact with oxygen, and inserting them in an atmosphere of pure nitrogen. From this he argues that the thermo-electric force in general is due to the contact of the gases which bathe the metals. The following experiment was tried to test the theory. By the kindness of Mr. Edison and Mr. Upton a vacuum tube was prepared in Mr. Edison's laboratory, containing an iron wire about 2 inches long, firmly joined to two platinum terminals which passed through the walls of the tube; the tube was exhausted until a 2-inch induction coil spark would not pass $\frac{1}{4}$ of an inch in the gauge-tube, indicating a residual atmosphere of about one-millionth. The wire was heated to incandescence during the exhaustion, in order to drive off any possible occluded gases. The platinum wires outside the tube were joined to iron wires, the joinings being covered by glass tubes slipped over them, and a sensitive reflecting galvanometer was included in the circuit. By laying the tube and connected joinings in the sunshine, and alternately shading one or several of the joinings, it was found that the electro-motive power of the joinings within the tube was precisely the same as that of those without, and the development of current just as rapid. There was no trace of any modification due to the exhaustion.—*Science.*

HENLEY'S TELEGRAPH WORKS COMPANY (Limited) were quite busy during September, turning out during the month about 100 miles of cable; some being for the Great Northern Telegraph Company, the West India and Panama Company, and the Submarine Company. Some torpedo cable was also manufactured for Captain McEvoy, and we believe for the Russian Government

SOCIAL SCIENCE CONGRESS.—Excursion on Saturday afternoon. Professor Geikie, having sketched briefly the geology of Arthur's Seat and the Salisbury crags, and called special attention to the centre of the Edinburgh coal-fields, the party proceeded to Parson's Green, the residence of Mr. D. Nicolson, where they were entertained to tea and other refreshments. Mr. Nicolson's fernery, which has few, if indeed any, equals in the country, was visited and greatly admired, as were also the gardens and grounds. Mr. Nicolson has his residence and his works, which are about a mile apart, connected by means of the telephone, and arrangements had been made to enable the company to observe the working of this ingenious instrument—a privilege that was eagerly taken advantage of.

DR. BEDDOE, on Health, said:—"It is not, perhaps, chimerical to expect that the cheapening and practical application of the electric light may make a considerable change in the conditions of some kinds of labour. The influence of light on vital action is in this country almost always favourable, and I am not aware of any evil resulting to man from the prolonged daylight of the Arctic Circle; but we can draw no conclusions bearing on animal life from Siemens' interesting experiments on the effect of the electric light on vegetation; for, as Buckle pointed out, the two kinds of life do not attain their highest vigour or perfection side by side, or under similar conditions."—*Scotsman*, August 11th, 1880.

THE JAMIN ELECTRIC LIGHT.—The directors of the Compagnie Générale des Panoramas, having recently made an exhaustive trial of the Jamin electric light at the Company's works in Paris, have decided upon the adoption of that system for the illumination of the panoramic exhibition which they are now preparing in Leicester Square. For this panoramic display, which is to be opened in due course under the name of the "Royal Panorama," they have recently erected extensive premises, which will also comprise a restaurant, café, and other accessories, the whole of which is to be illuminated by means of thirty Jamin lights, the arrangements for which are being carried out by Mr. J. A. Berly, C.E., the engineer to the company owning the Jamin light.

THE Dundee Police Commissioners have issued a public notice, dated 6th October, to the effect that every person who intends to erect any telegraph, telephone, or other wire within the burgh of Dundee shall, four days next before some meeting of the Works Committee of the Commissioners of Police for the burgh, give notice in writing of such intention at the office of the Surveyor of the Commissioners of Police, and also leave a plan showing the position and course of such intended wire, and detailed drawings showing

the methods of fastening and supporting the wires. The plan and detailed drawings must be accompanied by a duplicate copy or tracing, and by a description of the intended wire fastenings and supports: and that the erection of the wire shall not be commenced until the plan and drawings have been approved of by the Commissioners.

We understand that the above notice was called forth by the attention of the Commissioners being directed to the insecure manner in which some wires were being put up.

An inventor of New York proposes to utilise the swift current of rivers by systems of anchored floats carrying current wheels connected with electro-dynamo machines. The electricity thus generated might be conveyed to factories on the shores and set to work by means of electro-motors; or it might be used for lighting towns, or even for running trains on railways. —*Scientific American.*

An exhibition of light apparatus is being held at the Alexandra Palace, Muswell Hill. The electric light is represented by Mr. Crompton's lamp, and also by that of Mr. Hickley, the latter forming a portion of the extensive exhibit of Mr. Orme, of Barbican. There is also a capital show of telegraph cases by Mr. W. M. Foxcroft, the well-known maker of instrument cases. Beyond these exhibits there is nothing of especial interest to our readers worth mentioning. Paraffin lamps and stoves, wax candles, &c., are well represented. The electric light declines to shine any longer simply as a gratuitous advertisement.

We hear that the Charing Cross Station of the District Railway is to be lighted by the Jablochkoff system.

The *St. James's Magazine* for October contains the first instalment of a series of articles on "Lightning Protection for Telegraphs." The articles, though good of their kind, seem a little out of place in a popular journal.

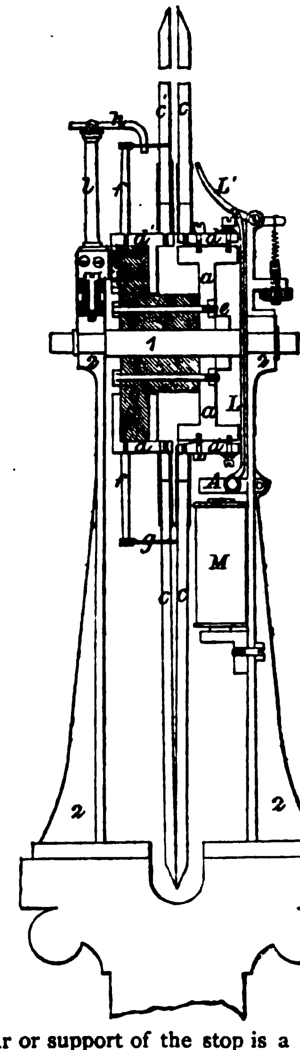
GATEHOUSE'S IMPROVED ELECTRIC LAMP.

The principal object of this invention (patent dated 25th November, 1879) is to enable any number of Jablochkoff or Wilde candles to be introduced and automatically put in circuit and ignited one after the other, so that on the consumption of one candle being complete another fresh one immediately takes its place. This is accomplished by self-acting arrangements of a more simple character and which are less liable to derangement than those hitherto proposed for the purposes above referred to.

The figure is a sectional side elevation of one of the automatic carbon candle holders, adapted for receiving radially disposed candles. 1 is a horizontal axle mounted between two standards, 2, 2, attached to which axle is a metal disc, *a*, carrying a number of carbon holders, *d*, for the reception of the radial carbon rods, *c*, each of the holders, *d*, being being capable of oscillating on a pivot or fulcrum. The carbons are mounted on their holders by means of a tubular socket piece attached to the bottom of the carbon and fitting over a pin in the holder, *d*.

Bolted to the metal disc, *a*, there is another disc, *b*, of wood, ebonite, or other insulating material, and to this second disc are fixed the separate carbon holders, d^1, for the reception of another set of radial carbon rods, c^1.

Attached to the axle and on to one of the standards there is fitted a spring, *e*, and at the other end of the axle a key can be applied for the purpose of turning the axle or discs round twice or thrice, and thus winding up the apparatus to a state of tension. If now the key be released the apparatus will tend to revolve of itself in the reverse direction, but it is held in tension by the following arrangement:—Attached to each of the carbon holders, d^1, there is a pin or rod, *f*, from which a piece of wire thread, *g*, forming stops is carried to the corresponding pair of carbon rods. These threads or stops catch against the adjustable catch lever, *h*, which is mounted on a pillar, *l*, on one of the standards, 2, but electrically insulated therefrom. Attached to



the pillar or support of the stop is a contact piece or spring, *k*, which establishes connection between the respective separate carbon holders, d^1, and a terminal on the base of the apparatus, to which terminal a conducting wire of a magneto-electric machine is attached, the other conducting wire of the said magneto-electric machine being attached to either of the standards. The apparatus, as shown in the figure, is supposed to be in a state of

tension and held in position by one of the wires or threads, *g*, bearing against the catch lever, *h*, the points of the carbon rods, *c*, c^1, having already been pressed together and held in contact by means of a conducting cement or a small cap of thin metal if desired. Now if a current of electricity be passed through the apparatus it will travel from the terminal, to which a wire from the machine is attached, through the contact piece, *k*, and corresponding carbon holder, d^1, up the carbon rod, c^1, and down the corresponding rod, *c*, to the disc, *a*, and axle, 1, and so on to the standard, 2, to which the other wire of the machine is connected. The passage of the current ignites the candle, the ends of the carbon rods spring asunder, and the electric arc is established and continues burning until it reaches the thread or stop, *g*, which is instantly fused or partially destroyed. This allows the spring, *e*, to act, and another candle is immediately brought into the position of the one consumed, and is set alight before the first is actually extinguished, owing to the fact that the contact piece, *k*, is made to touch the second carbon holder before it has actually left the first, so that by this means a momentary extinction even of the light is avoided, as the circuit is not broken. This second candle is consumed in the same manner as above described, until it reaches its thread or wire, *g*, which on being fused allows the third candle to come up, and so on until all are consumed. In lieu of joining or holding together the carbon points as described, momentary contact can also be established between them by means of the electro-magnet, M, which is used for the purpose of relighting any candle which may have become accidentally extinguished before it has burned down to the thread or stop, *g*. This electro-magnet forms a shunted circuit to that of the main current passing through the carbons, and its armature, A, is entirely separate and distinct from the holders, *d*. If a candle should go out the whole of the current would necessarily pass through the electro-magnet, M, and the armature, A, would consequently be attracted, pulling down the rod, L, and causing the adjustable lever, L^1, to impart a smart blow to the side of the carbon, *c*, the holder of which is pivotted either on a centre or on a knife edge as shown. This carbon rod, *c*, would therefore be brought into momentary contact at its upper end with its corresponding carbon, c^1, and the electric arc re-established. If the carbon rods in the normal state are left open at the points instead of being joined with conducting material it would not be necessary that the rods, c^1, should be in separate holders insulated from each other, as in the figure, as a complete or unbroken ring of metal could in that case be used for the contact piece, *k*, to bear or rub against, since the current could only pass through that particular candle which happened to be opposite the striking lever, L^1. The candles may be disposed in a circle parallel to each other like the teeth in a crown wheel, in lieu of radially. This arrangement takes up less room than the plan first described, though the principle of the automatic working is the same.

There can be no doubt but that Mr. Gatehouse's invention could be applied with very great advantage to the existing Jablochkoff systems, which at present require a wire for each candle; this adds very considerably to the mileage of wire when the current is carried over long distances, as on the Thames Embankment for instance. Besides, the invention allows of the full length of candle being consumed and does not bring a new one into action until this has taken place.

New Patents—1880.

3880. "Improvements in systems of conductors for the distribution of electricity as a lighting and motive-power agent, and appliances connected therewith." P. JENSEN. (Communicated by T. A. Edison.) Dated September 24.

3885. "Improvements in telephonic apparatus and in the method of and the apparatus for transmitting articulate and other sounds." W. MORGAN BROWN. (Communicated by A. G. Bell.) Dated September 25.

3894. "A new and useful system of electro-magnetic railroads, and appliances and methods employed therein for the generation, distribution, and translation of electricity." (Communicated by T. A. Edison.) Dated September 25.

3925. "Construction of and method of testing lightning conductors." S. VYLE. Dated September 28.

3928. "Apparatus for the generation and utilisation of electricity." W. R. LAKE. (Communicated by E. Thomson.) Dated September 28.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

573. "Closing or emptying water pipes or other fluid conduits, &c." H. J. HADDAN. (A communication from F. Fried, of Frankfort.) Dated February 10. 2d. For actuating the valves automatically a wire from a battery is connected with a vessel containing mercury, which rises through a narrow neck when the temperature is raised, thus effecting contact. (*Provisional only.*)

671. "Electric telegraph for railway trains." G. DALSTRÖM. Dated February 16. 6d. Consists in arranging telegraph wires along lines of railway and in connection with trains, so as to place each running train in uninterrupted telegraphic communication with the various stations as also with every other train on the same line. The invention consists of two parts—1, the specially arranged conducting wire, and, 2, the apparatus by which communication between such wire and the train is established. One carriage of each train carries a roll or rolls of metal on which bears one of the telegraph wires (such wire being doubled at the points of suspension), the current is transferred to these rolls and thence by a special wire to a common telegraph apparatus in the carriage used when telegraphing. From the apparatus the current is then conducted to the covering-plates of the vehicle and directly to the frame thereof and so to the rails.

752. "Magnets and telephones." F. J. CHEESEBOROUGH. (A communication from A. K. Eaton, Brooklyn, U.S.A.) Dated Feb. 20. 6d. Consists of a multipolar magnet, either permanent or temporary, constructed in such manner that two or more similar poles will react with one of an opposite character, the latter being the equivalent of all the others, and also in its application to a diaphragm or the diaphragms of a telephone. The object is to secure the greatest possible sensitiveness in the plate of the receiver.

756. "Electrical conducting wires." A. W. L. REDDIE. (A communication from H. Menier, of Paris.) Dated Feb. 20. 2d. A fine metallic leaf or powder is made to adhere to the surface of the insulating covering by means of tar. (*Provisional only.*)

814. "Telephone wires or cables." J. H. JOHNSON. (A communication from F. A. Gower, of Paris.) Dated February 24. 6d. Intended to obviate the liability of induction on telephone wires, and consists of an insulated conductor covered externally with a wire wound in helical coils, the latter being provided as a protection to the conductor and its insulator, and also as a wire for the return to earth.

832. "Electric lamps." Hon. R. T. DUDLEY BROUGHAM. Dated February 25. 6d. Consists in surrounding the vessel containing the lamp with another and separate vessel, preferably of glass. Into this separate vessel is placed any suitable liquid—pure water, for example—tinted or otherwise, or some materials, such as silicate, cotton, or asbestos filaments. So long as the water in the separate vessel is above the joint no atmospheric air can enter, while at the same time the heat of the lamp is carried off or dispersed and the light diffused. The invention is applicable to various lamps, such as those of André, of Edison, of Jablochkoff, &c.

834. "Moorings for buoys." W. C. JOHNSON and S. E. PHILLIPS. Dated February 25. 2d. See *Telegraphic Journal*, vol. viii., p. 190. (*Provisional only.*)

842. "Producing electric light." A. M. CLARK. (A communication from L. J. Bouteilloux and W. Laing, both of Paris.) Dated February 25. 6d. Relates to an electric lamp in which the carbons are regulated automatically by the action of gravity, a special arrangement of the carbons being employed, consisting of an ordinary carbon and a carbon having a central core of a non-conducting material, with the centre of which the point of the other carbon is in contact, the weight of the one resting on the other. The voltaic arc extends between the point of the solid carbon and the circumference of the annular carbon, the regulation being effected automatically by the more or less rapid fusion of the non-conducting core, according to the intensity of the current.

849. "Dynamo-electric machines." H. J. HADDAN. (A communication from C. F. Brush, of Cleveland, Ohio, U.S.A.). Dated February 26. 6d. Has for its object the adaptation of dynamo-electric machines to variable external conditions without variation of the speed at which their armatures are rotated, but by variation of the intensity of the magnetic field. The magnetic field is weakened either by shunting away from the coils of the field-magnets a portion of the current which excites them, or by cutting out or short-circuiting some portion of one or more of the coils, so that the current shall make a less number of convolutions about the cores of the magnets.

855. "Apparatus for lighting gas." C. L. CLARKE and J. LEIGH. Dated February 26. 2d. Consists of a hand lamp or apparatus, with a special battery arrangement, an induction coil, and platinum wire to be rendered white hot by the passage of the current. (*Provisional only.*)

860. "Magnetic appliances and garments." G. GREEN. Dated February 27. 2d. Cloth, flannel, or other suitable fabric is employed, on which is placed a layer of zinc gauze, to which is attached a layer of copper or other suitable metal gauze, the whole being connected with wire which forms the necessary conductor to different parts of the appliance. (*Provisional only.*)

872. "Magneto-electric and dynamo-electric machines." D. G. FITZ GERALD. Dated February 28. 6d. Relates to improvements in above machines, and consists, 1st, in the combination with a ring or cylinder-shaped armature of permanent or electro-magnets of double curvature, such as will encircle the ring armature both longitudinally and transversely; 2nd, in the combination of an electro or permanently magnetic ring constituting two magnets, having their similar poles opposed in a plane transverse to the ring armature; and, 3rd, in the combination with a revolving coiled ring or cylinder of stationary inducing coils completely encircling the revolving coiled ring or cylinder.

878. "Pneumatic telegraph apparatus." W. MORGAN BROWN. (A communication from Count G. de Monti, of Paris.) Dated February 28. 6d. Consists of a pneumatic telegraph apparatus in which a pressure of air arriving through suitable tubes operates a lifting plate, which in its turn acts through suitable intermediate mechanical parts so as to expose to view a number or other mark on an indicator, at the same time setting in motion an alarm apparatus driven by a coiled spring, which alarm is common to all the numbers or marks contained in the apparatus.

885. "Producing motive power and light by electricity." J. GRADDON. Dated February 28. 2d. (*Provisional only.*)

886. "Apparatus for obtaining electricity." C. W. HARRISON. Dated February 28. 2d. A series of helices or coils is employed and in combination therewith an interior central bar or tube, or series of bars or tubes, the motion of which within the said helices and in the direction of their length causes electric currents within them. (*Provisional only.*)

899. "Combined galvanic batteries and medicated pads for the cure of bodily diseases." A. M. CLARK. (A communication from H. E. Hunter, of Hinsdale, U.S.A.) Dated March 1. 6d. Consists in a galvanic battery formed of zinc, felt, and copper, and a medicated pad, so that a current of electricity may be incited by moisture from the patient's body; and also in the combination of a spiral conduction wire with two batteries and pads so that the current passes through them and the patient's body. The patient is also to obtain benefit from the medicaments contained in the pad.

925. "Electric lamps." J. H. GUEST. Dated March 2. 6d. Difficulty has been experienced in making electric lamps in which the conducting wires pass through glass to the carbon or other incandescent conductor within a globe from which the air is exhausted in consequence of the variation in temperature causing injury to the glass by expansion of the conducting wires. The invention is for sealing the glass at the places where the conductors pass through the same. Two or more fine wires are twisted together and passing through the glass; the glass is melted so as to flow in between the wires, and thus prevent the passage of air, and the wires being in a twisted form, instead of straight as heretofore, yield as they expand, and hence the glass is not cracked, and two or more small wires can be used, having sufficient combined conducting power not to become heated by the passing current.

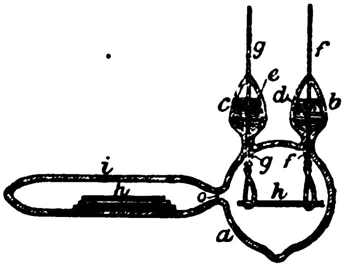
Cups for mercury are made around the conductors where they pass to the glass, such cups being also of glass, and placed so that the mercury forms a complete seal around the conductors, and prevents the possibility of air coming into contact with the joint between the glass and metal.

The light-giving body that is rendered incandescent by the passage of electricity may be of carbon or other suitable material in the circuit between the two conductors.

The glass bulb or globe is exhausted of air.

The figure is a section of the lamp with a magazine for carbon.

The glass bulb or holder, *a*, contains the carbon, *h*, and the two conductors, *f* and *g*, pass through the glass, and are attached to the carbon or other light-giving body that is rendered incandescent by the passage of the electric current.



The cups, *b* and *c*, surround the conductors where they pass through the glass, and the mercury at *d* and *e* forms a seal to prevent the possibility of air leaking into the vacuum bulb.

It sometimes is important to introduce a carbon in place of one that may be injured or consumed. To provide for this there is a glass magazine, *i*, shown at the side of the globe or bulb, *a*, with a small opening at *o* from the magazine into the bulb, so that one carbon may be shaken from time to time out of the magazine into the loops in the conductors, or any other suitable carbon holders may be provided in place of the loops.

The conducting wires, *f* and *g*, are formed of two or more wires twisted together and passing through the glass.

941. "Telephonic apparatus." R. H. COURTENAY. Dated March 3. 2d. Consists principally in the substitution for carbon, in telephonic transmitting, of carbonates or other suitable salts of metals, and the metals also in a finely divided state, and also an alloy of metals of variable electrical resistance. (*Provisional only.*)

963. "Detecting and estimating quantity of fire damp." J. AITKEN. Dated March 5. 6d. To telegraph warning of an unsafe condition of the air at the place where the instrument is situated an ordinary mercurial thermometer, the bulb of which is covered with a catalytic substance, may be used; the mercury rising to a certain temperature makes electric communication, and thus transmits signals in the usual way.

1475. "Telegraphic cables or conductors." F. WIRTH. (A communication from M. M. Manly, R. P. Manly, and W. J. Phillips, of Philadelphia, U.S.A.) Dated April 10. 8d. Consists in fixing a tube and the wire at their lower ends, straining them constantly upwards, and filling the tube by forcing the molten insulating material into its lower end; in keeping the wire and tube under a yielding tensile strain while cooling after filling, and keeping the insulating material at the same time under pressure applied at both ends of the tube; where more than one wire is to be introduced, in threading the ends of the wire through perforation in two plugs, one of which is of a size to pass through the tube to be filled and which is drawn through it, the other plug being secured against inward movement. Also in cooling from the bottom gradually upward the aforesaid vertical tube. In twisting each section of cable (the wire and insulating material) after it has been filled and cooled, so as to permit the cable to be reeled without displacing the wires. The twisting is effected by clamping a suspended section of cable by its lower end to a fly-wheel, the wheel being then revolved about fifteen times. Likewise it relates to an arrangement of wires in a multiplex insulated telegraph cable having for its object to reduce retardation and interruption by inductive influences, and consists in providing a telegraphic cable of two or more conducting wires with an independent wire adapted for connection with the ground at points intermediate of the length of the cable. The independent wire not connected with the wires of the cable at any point.

1553. "Electric lamps." C. D. ABEL. (A communication from the Compagnie Générale d'Eclairage Electrique of Paris.) Dated April 16. 6d. Consists in providing means whereby a Jamin lamp (see *Telegraphic Journal*, vol. viii., p. 213) is kindled when it is brought into circuit, and becomes excluded from the circuit when its carbons are consumed. One of each pair of carbons is held in a socket hinged to the framing, and so loaded that when left free the carbon becomes inclined till its point bears against the point of the other carbon, permitting passage of electricity and thus kindling the carbons; the electrical loop within which the carbons are is inclosed in an iron sheath, so that when the current passes this sheath becomes magnetic and attracts a spring armature, a stud on which, bearing against the movable carbon, pushes it away from the other carbon to the distance suitable for maintaining the arc. One carbon of each pair is pressed by a spring against a stud of fusible metal near its root, so that when the carbons are sufficiently consumed the metal is melted and the spring then pushes one carbon from the other so that the electrical circuit is broken. When several lamps are in the same circuit, if one should be extinguished the general circuit will nevertheless be maintained in the following manner:—The main conductor instead of being led directly to each lamp divides into two branches. One branch passes through the coil of an electro-magnet through the lamp and back to the main conductor beyond the magnet. The other branch passes through the armature of the electro-magnet, a contact, a resistance about equivalent to that of the lamp, and back to the conductor.

1998. "Magneto-electric machines." W. R. LAKE. (A communication from C. A. Seeley, of New York.) Dated May 14. 6d. A machine is described in which the efficient portions of the wire of the armature revolve within, and the connecting portions of the wire revolve

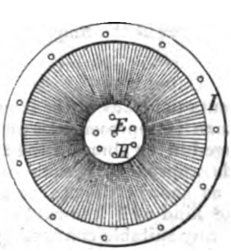


FIG. 1.

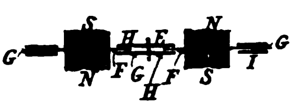


FIG. 2.

without, the magnetic field. The said armature is made as nearly as practicable in the form of a disc, and revolves between magnetic poles of opposite name. It may be considered as a modification of the device

known as "Arago's disc." The difference being that in this disc armature the currents produced in precisely the same way are kept apart and carried away.

In the common form of this disc device the induced currents find in the conducting matter of the disc direct paths of reunion, and thus the electricity is almost wholly transformed into heat, while in the disc armature the currents produced in precisely the same condition are kept apart and carried away.

Fig. 1 is a face view of the disc armature, and fig. 2 is a transverse section through the centre of the same. E is the axis; F is the radial part of the winding; G, G, are other parts of the winding; H, H, are circular plates or rings of metal, or other suitable material for binding in place the outer sides of the sectors.

In fig. 2, N, N, S, S, are four magnets in the proper position relatively to the armature; the disc revolves between magnets of opposed polarity.

The sectors may be connected in series or in multiple arc, and be united with commutators of the ordinary construction. It will be observed that only the radii or radial parts of the wire of the armature are efficient for the electro-magnetic induction, while the circumferential parts serve only as connectors for the radii.

2418. "Transmitters for telephones." R. M. LOCKWOOD and S. H. BARTLETT, of New York. Dated June 15. 6d. The effectiveness of these transmitters depends not upon the mechanical vibration of a diaphragm but upon what is termed molecular movement, inasmuch as the atmospheric sound waves are transmitted from molecule to molecule of a non-resonant material, which as a body remains stationary while serving as a conducting agent between the said sound waves and the microphone which controls the volume, pitch, and variations of sound transmitted to and through the wires. A microphone of any suitable character is provided with transmitting wires, and is either wholly or partly embedded in cork, light wood, or other non-resonant material.

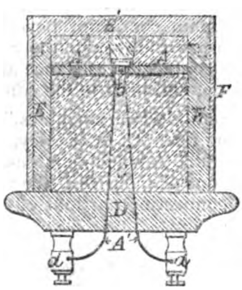
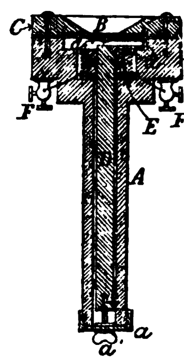


Fig. 1 represents the transmitter in section.

The microphone is represented as composed of two bars, A A, arranged in or about in the same plane, with their inner ends approaching each other but out of actual contact, as shown. These bars are preferably of carbon of the kind well known to electricians, but they may be of any suitable conducting material, such as metal, which, however, as far as experiments have extended, has been found inferior to the carbon in its results. The adjacent ends of the bars, A A, have semi-cylindrical notches cut in them opposite each other, forming a circular opening between the bars for the reception of a pin, *b*, on the lower face of a small button or disc, B, of carbon or other conducting material similar to that of which the bars, A A, are composed, said button resting by gravity on the inner ends of the bars.

The microphone thus formed is imbedded in a mass or block, C, of cork, light wood, or other material, possessing as far as may be the peculiar non-resonant property of cork. This block or body of the transmitter may be made in any suitable form, such as that of a cube, that shown being in the form of a short cylinder supported upon a base plate, D, to which the binding posts, *d d*, may be attached, as shown, the wires, A¹ A¹, attached to the bars, A A, and passing out through the block being connected therewith, and thence with the main line wires or directly with the latter as preferred, the former arrangement facilitating the detachment of the transmitter when desired. The block of non-resonant material may have a chamber formed in it, as shown at B¹, the inner adjacent ends of the bars, A A, projecting into said chamber, leaving them only partially imbedded while still supported in the non-resonant material, but it is preferred to imbed them in said material throughout their whole length, and to fill the aperture over the button for affording access thereto with a plug of non-resonant material out of actual contact with the button, but sufficiently near thereto to prevent its displacement in handling the transmitter. It is preferred, also, to snugly inclose the block of non-resonant material in a metal cylinder or casing, E, having a screw cap or cover, E¹, and to wrap said case with a sleeve of leather, rubber, canton flannel, or other soft non-resonant material, as tending still further to prevent mechanical vibrations, but these may be omitted, as without them the non-resonant block, C, is found to answer admirably for the body of the transmitter, with the microphone embedded therein as explained.

2419. "Telephone receivers." R. M. LOCKWOOD and S. H. BARTLETT, of New York. Dated June 15. 6d. The diaphragm is formed on or attached to a reduced arm forming an extension of one pole of a single bar magnet, which so supports the diaphragm as to make it constitute a sounding board, to which the dis-



turbances in the current are conveyed by molecular action or by difference in degree of polarity in different parts of the pole to which it is connected, rather than by mechanical vibration of the diaphragm due to its attraction and repulsion by the magnet as in the usual construction.

In the figure, A represents the handle or body of the receiver, made preferably of wood, cylindrical or tubular in form, with an enlargement at one end forming the head, A¹, to which the ear-piece, C, of any usual or preferred form, is secured. The handle is perforated longitudinally to receive the straight bar magnet, D, the perforation in the head part, A¹, under the ear-piece being enlarged into a socket or chamber for the reception of the helix, E, surrounding the end of the magnet projecting into said socket.

Under the construction and arrangements of parts shown and described it will be seen that the spring arm, $d\,d^1$, forms an extension of the pole, D^1, of the magnet reduced in size and spread out so as to form a diaphragm, and its normal condition will be one of rest in relation thereto. Thus, supposing the current in the helices to be represented by "one," then the amount of magnetism in the magnet at D^1 will be "one," and that in the arm, d^1, will also be "one," and the latter will be at rest. But the body of the magnet lies within the helix, and is more quickly affected by it, and constitutes as it were a reservoir, from which the small arm, $d\,d^1$, is supplied. Now, supposing the current in the helix to be disturbed or suddenly increased to "two" the end or pole, D^1, becomes "two," in advance of the arm, d^1, and for the instant attracts the latter until it also becomes "two," when it is instantly repelled; then its normal condition as a part of pole D^1 being restored it returns to its normal position of rest until it is again attracted or repelled through another disturbance of the current in the helix. Thus, for each disturbance in the current there would be three distinct movements of the arm, d^1, and of the diaphragm, B, connected therewith as follows:—First it is drawn down toward end D^1, then it is repelled beyond its normal position, and, finally, the equilibrium being restored, it moves back to its normal position of rest. It will thus be seen that the diaphragm is operated by disturbances or differences in degree of polarity or attraction and repulsion in different parts of the pole to which it is connected, and of which it forms a part.

City Notes.

Old Broad Street, October 14th, 1880.

THE EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY, LIMITED.—The report for the six months ended 30th June, 1880, presented at the fourteenth ordinary general meeting of the Company, held at the City Terminus Hotel, Cannon-street, on the 6th of October, stated that the gross receipts for the half-year have amounted to £173,020 0s. 11d., against £150,107 11s. 5d. for the corresponding half-year of 1879, showing an increase of £22,912 9s. 6d. The working and other expenses (including a sum of £17,703 7s. 2d. for cost of repairs and renewals of cables and expenses of ships), together with interest on debentures, contribution to sinking fund for redemption of debentures, and income tax, absorb £77,484 10s. 6d., leaving £95,535 10s. 5d. as the net profit of the half-year. One quarterly interim dividend of 1¼ per cent., amounting to £24,968 15s., has been paid during the half-year, and it is now proposed to distribute another of like amount, together with a bonus of one shilling per share, payable on the 15th October, leaving a balance of £35,610 10s. 5d. to be carried forward. The cable between Hong Kong and the Island of Luzon (Manila) was successfully laid by the Telegraph Construction and Maintenance Company, and opened for traffic on 8th May last. In pursuance of the powers conferred by special resolution of the general meeting, held on the 22nd October, 1879, authorising the raising of capital for the purpose of laying this cable, the directors have issued £100,000 in 5 per cent. debentures, which have all been subscribed by the shareholders. The balance of the contract money (£20,000) will be taken from the reserve fund. The Company's cables have worked well during the half-year, and are now in good electrical condition. The South Australian Government have continued to maintain their important land line from Port Darwin to Adelaide in excellent working order. The directors having from time to time received applications for assistance to the relatives of deceased members of the staff, have considered it desirable to establish an assurance fund on the same principle as that recently sanctioned by the shareholders of the Atlantic, the Eastern and other telegraph companies, the object being to enable the staff to secure the payment of a limited sum to themselves at a fixed age or to their families in case of their death, the Company paying one half of the requisite premiums. It is estimated that, if this plan is availed of by the *employés* generally, the cost to the Company would be about £1,500 per annum. The chairman, Mr. J. Pender, in moving the adoption of the report, said that of the increase of £22,913 in the gross receipts, £10,000 only was due to increased traffic, the remainder representing additional subsidies. In respect of the duplicate Australian cable, they received £10,800 for four months, for the Malacca cable £500 for six months, and for the Manila cable £1,466 for two months. The working expenses for the past half-year amounted to £49,775, against, in the corresponding period of last year, £54,950, showing a decrease of £5,175. This decrease was accounted for by a saving in the cost of repairs and a saving in the maintenance of ships. Six months ago, when the question of dividend arose, he had stated that it was most desirable that they should have a large reserve fund, but that if in the course of six months they found that their traffic was keeping up, and that they could still put to the reserve the amount they had been doing in the previous half-year, they would then consider the question of an increased dividend. They always desired to meet the wishes of the shareholders, but at the same time, knowing the importance of having a good reserve fund, they had felt bound to keep the matter under consideration. The best evidence he could give of the value which attached to a reserve fund was that their shares, which two years ago stood at something like £8, were now at a premium. If they had spent all the money they had earned in dividends, they would not have stood in so favourable a position at the present time. The board had determined to keep to a steady dividend of 5 per cent., and as the profits admitted, to distribute a bonus, so that the bonus alone would be fluctuating. To show the importance of the telegraph system in bringing nations more closely together he mentioned that the Exhibition at Melbourne was opened on the 1st inst., and that within twenty-three minutes of the opening of the Exhibition the fact was announced in London. That telegram of 69 words passed over 4,328 miles of land cable and 9,070 miles of submarine cable. Mr. W. N. Massey, M.P., seconded the motion, which was unanimously adopted after a short discussion relative to the form in which the accounts were made up. The chairman then proposed, and Mr. Massey, M.P., seconded the resolution to the effect that the board should be authorised to assist *employés* of the Company to effect assurances upon their lives by contributing out of the funds of the Company not more than half of the premiums required. The total amount so contributed not to exceed £1,500 a year. This was adopted unanimously, and the proceedings closed with a vote of thanks to the chairman.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.—Mr. C. M. Hooper informs us that the accounts to 30th June last show a balance to the credit of revenue account, including the balance from last half-year, of £15,841, but in consequence of the interrupted condition of the Company's system the directors have placed the sum of £10,000 to reserve account, and

will recommend at the approaching meeting that the balance of £5,841 be carried forward to the current half-year's accounts.

Reuter's Telegram Company, Limited.—The directors have declared an interim dividend at the rate of 5 per cent. per annum for the half-year ending 30th June last.

Direct Spanish Telegraph Company, Limited.—The ordinary half-yearly meeting of this Company was held on the 30th Sept. at the offices of the Company. The report (see *Telegraphic Journal*, October 1) was taken as read. The Chairman, Mr. Neil Bannatyne, after recapitulating the contents of the report, and adding a few remarks thereon, moved its adoption. The motion having been seconded, it was carried unanimously. A shareholder asked if there were any reasons for the Spanish Government delaying remitting the amount due from that Government. Mr. Bannatyne responded in the negative, adding that the time allowed was only in accordance with the condition of the Telegraph International Administration. The usual votes of thanks having been passed, the proceedings terminated.

The Direct United States Cable Company notify that the interest due 15th October, 1880, on their 6 per cent. debenture loan, will be paid on and after that date at the Consolidated Bank, Threadneedle Street, E.C.

The directors of the Globe Telegraph Company announce an interim dividend of 6 per cent. per annum on the Preference shares, and of 4 per cent. per annum on the Ordinary shares, for the quarter ending the 18th instant.

A correspondent in a daily contemporary says that the French Government having refused to allow the Anglo-American Company to again raise their tariff by the old French cable belonging to them, the latter can only charge sixpence per word by that route, and hence the ability of McLean's and other agencies to transmit messages, if addressed *viâ* France, at the rate of one shilling per word.

The following letter addressed to the editor appeared in the *Evening Standard*:—

"The Investors' Protection Association,
"Commercial-buildings, Leeds, Oct. 11.

"Sir,—With reference to the announcement by the Anglo-American Telegraph Company of a quarterly dividend of ½ per cent. on the ordinary stock, I am directed to state that a motion is about to be made in the Chancery Division of the High Court of Justice for an injunction to restrain the payment of the same, or of any further dividend until an adequate fund has been provided for the renewal of the company's seven millions' worth of perishable property. The grounds upon which the injunction is sought are precisely those which were successfully urged in the recent suit of 'Davison *v.* Gillies' (London Tramways Company). In that case it was distinctly laid down by the Master of the Rolls that profits available for dividend purposes meant 'net profits after setting aside a proper sum for depreciation (as in an ordinary business undertaking) of the property from wear and tear.' It is admitted that the dividend just announced by the Anglo Company is to be paid entirely at the expense of the renewal fund, which course seems to be all the more unwarrantable by reason of that fund having recently been nearly, if not quite, swept away. We are advised that there will be no difficulty in obtaining the *ad interim* order asked for.—I am, Sir, your obedient servant,

"Joseph B. Chapman, Secretary."

The Brazilian Submarine Telegraph Company, Limited.—The report of the directors for the half-year ended June 30th, 1880, states that the revenue for this period amounted to £78,036 18s. 6d.; the working expenses to £11,707 10s. 10d., leaving a balance of £66,329 7s. 8d.; to this is added £34,221 12s. 11d., the undivided profits to 31st December last, making a total of £100,551 0s. 7d. After deducting income tax, £947 2s. 8d., there remains a balance of £99,603 17s. 11d. A third interim dividend amounting to £16,250 has been distributed since the last accounts were presented, leaving the sum of £83,353 17s. 11d. for appropriation. The directors now recommend the declaration of a final dividend of 2s. 6d. per share, making a total dividend of five per cent. for the year ending 30th June, 1880, and also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £29,250, being a distribution in the aggregate of six per cent. for the past year, leaving a balance of £54,103 17s. 11d., of which amount £50,000 has been placed to the reserve fund, increasing that fund to £285,245 19s. 2d., and £4,103 17s. 11d. carried forward. The Company's cables continue in good working order. By Article 76 of the Articles of Association, Mr. Matthew Hutton Chaytor and Mr. William Henry Clark will retire by rotation, but being eligible for re-election, they offer themselves accordingly. The two auditors, Mr. Henry Dever and Mr. John Gane, also offer themselves for re-election. The summary of traffic receipts is as follows:—For twelve months July, 1874, to June, 1875, £128,461; 1875-6, £129,038; 1876-7, £131,507; 1877-8, £134,003; 1878-9, £139,654; 1879-80, £154,957.

The following are the final quotations of telegraphs:—Anglo-American Limited, 63½-64; Ditto, Preferred, 94-94½; Ditto, Deferred, 33¾-34¼; Black Sea, Limited, ——; Brazilian Submarine, Limited, 10-10½; Cuba, Limited, 9-9⅜; Cuba, Limited, 10 per cent. Preference, 16¼-16¾; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11¾-12¼; Direct United States Cable, Limited, 1877, 12¾-13; Scrip of Debentures, 103-105; Eastern, Limited, 9⅞-10⅛; Eastern 6 per cent. Preference, 12⅜-12¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 107-110; Eastern 5 per cent. Debentures, repayable August, 1887, 102-105; Eastern, 5 per cent., repayable Aug., 1899, 104-106; Eastern Extension, Australasian and China, Limited, 10⅝-10⅞; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 109-112; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 105-107; Ditto, registered, repayable 1900, 105-107; Ditto, 5 per cent. Debenture, 1890, 102-104; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 102-104; Ditto, ditto, to bearer, 103-105; German Union Telegraph and Trust, 9¾-10¼; Globe Telegraph and Trust, Limited, 6¾-7; Globe, 6 per cent. Preference, 12-12½; Great Northern, 9¾-10; Indo-European, Limited, 24½-25½; London Platino-Brazilian, Limited, 4¾-5¼; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 10-11; Submarine, 240-250; Submarine Scrip, 2¼-2½; West Coast of America, Limited, 2¾-3; West India and Panama, Limited, 1¼-1½; Ditto, 6 per cent. First Preference, 6¾-7¼; Ditto, ditto, Second Preference, 6½-7; Western and Brazilian, Limited, 7⅜-7⅝; Ditto, 6 per cent. Debentures "A," 105-107; Ditto, ditto, ditto, "B," 96-99; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 103-105; Telegraph Construction and Maintenance, Limited, 34¾-35¼; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3¾-4; India Rubber Company, 15¾-16¼; Ditto 6 per cent. Debenture, 103-105.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

Vol. VIII.—No. 186.

A NEW ERA IN PUBLIC LIGHTING.

Inventors are still working hard to perfect or invent dynamo machines and electric lamps, indeed it seems that at the present time this branch of electrical science is receiving more attention than all the other portions combined.

It is doubtful if *much* improvement is possible on the well known machines already in the market, unless, indeed, some great discoveries should indicate an entirely fresh direction to thinkers in that field of investigation, but this seems hardly possible.

A good lamp, simple yet effective, durable yet economical to manufacture, is, we believe, still a desideratum; but both machines and lamps are for most practical purposes sufficiently good for the electric light to have made much more rapid advancement than it can be said yet to have done.

Why then is the development progressing so slowly? The reason, we think, is partly, perhaps largely, to be accounted for by the fact that hitherto most individuals or firms desiring to use the electric light have found that to obtain the necessary plant entailed too extensive an addition to capital expenditure. And this, particularly as the advantage of the light, in point of *general economy*, when used on such a scale as for warerooms, &c., is still held by some to be doubtful. If an instance were wanting to prove the pecuniary advantage when the electric arc is largely used, we might quote Mr. Swan's words in speaking before the Literary and Philosophical Society at Newcastle. That gentleman said that, at the Alexandra Palace two thousand gas lights, costing twenty-six shillings per hour, had been replaced by six electric lamps, costing only six shillings per hour.

What undoubtedly is now wanted is the central system for the supply of the electric current in large or small quantities; and this supply obtainable on analogous terms to those required for a supply of gas. If every one wishing to use gas were obliged to purchase the necessary plant for so doing, and superintend the working thereof, we think his ardour in that direction would be considerably damped, and most probably some other method of lighting ultimately adopted. It is with satisfaction then that we note that the central system is engaging the attention of two or three most influential firms on this side the Atlantic, and we also read that one of the companies in America interested in the Brush light is about projecting a similar system there. When once a success is scored the adoption of the electric light will progress with more and more marked rapidity. The public will be satisfied with the increased light or greater economy, and those who invest their capital in electric light shares, will, we believe, have no reason to be dissatisfied with their profits.

HEINRICHS' NEW RING ARMATURE AND THEORY OF THE GENERATION OF ELECTRIC CURRENT IN A RING ARMATURE.

A further improvement on the Pacinotti* ring armature has been made by Mr. Charles F. Heinrichs, the inventor of the electric lamps with circular carbon pencils.† As this improvement is of an important nature, and possesses very promising features, we shall fully describe its principle and advantages.

Mr. Heinrichs was led to devise the new form of armature through a close study of those of the existing forms, and by observing the manner in which the electric currents are generated in them; by this he formed a theory as to the action which the soft iron ring takes in the generation of electric currents in its surrounding insulated conducting-wire. Of this theory we shall make use in this article, with Mr. Heinrichs' permission. We shall have to refer to other already known ring armatures which are improvements on the Pacinotti ring, and we shall have also to draw comparison between those and the new one of Mr. Heinrichs, without which we could not well describe its novelty and features. Several theories have been advanced to explain the part which the soft iron ring plays in the generation of electric currents in the armature, but we have not yet seen an entirely satisfactory explanation of the action which the soft iron ring takes when in motion.

M. Antoine Breguet explains the action of the soft iron ring in his small pamphlet, "La Machine de Gramme," and part of his explanations are confirmed by Mr. Heinrichs' theory, as we shall see later on; but we think Mr. Heinrichs has gone a good deal further, and has not only endeavoured to discover the disadvantages of the existing armatures, but also constructed a form of the latter in which he overcomes those disadvantages in a satisfactory and simple manner.

It is well known that when a piece of soft iron is brought with one of its ends close to a magnet (fig. 1) this piece of soft iron will become also a magnet, and the one end nearest to the magnet acquires south polarity and the other end north polarity. In the middle of the piece of soft iron a neutral line, *l l*, will be established, and if the piece of soft iron were surrounded with insulated conducting-wire, a current would be set up or generated in the entire length of the wire *in one direction*. As is well

* See *Telegraphic Journal*, vol. vii., p. 217.
† See *Telegraphic Journal*, vol. vii., p. 311.

known, this is the principle on which all so-called magneto-electric currents are generated.

If now we change the inducing magnet to the position shown in fig. 2, then we shall find that the neutral line, *l l*, now lies through the length of the iron, and that one half of the latter has acquired south and the other half north polarity throughout its length, and if this piece of iron were again surrounded with insulated conducting-wire, a current would be set up in the wire in a very different manner from that shown in fig. 1.

Supposing we take the inducing magnet away from fig. 2, but let the piece of iron have the two polarities as shown, then a current would be set up in that portion of the insulated conducting-wire which overlies the south polarity of the iron, but the direction of this current would be the reverse of that set up in those portions of the insulated conducting-wire which overlie the north polarity of the iron, and both currents being of equal strength would neutralise one another, and heat in the insulated conducting-wire will be the only effect produced.

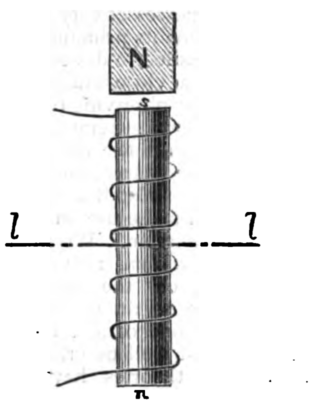


Fig. 1.

If we again approach the inducing magnet we shall find that the currents set up in those portions of the insulated conducting-wire which overlie the south polarity of the iron, and which are also directly under the inductive influence of the inducing magnet, will be of great strength and will neutralise the current set up in a reverse direction in those portions of the wire which surround the north polarity of the iron, but then, the one current being stronger than the other, a resulting current equal in strength to the difference between the two will flow.

Again, if the inducing magnet, N (fig. 2), is of great magnetic power and the piece of soft iron thin, then the before-described generation of current will take place when we are yet at a distance from the powerful influence of the inducing magnet, N, but when the iron approaches close to the powerful inducing magnet it will neutralise the north polarity of the former, and the whole piece of iron will acquire south polarity; in this case the current set up in the insulated conducting-wire will circulate throughout the whole length of the wire *in one direction*, as in fig. 1, but it will be of greater strength, since the inductive influence of the inducing magnet upon a great portion of the insulated conducting-wire is added.

We have seen, therefore, that in fig. 1 a current will be set up in the insulated conducting-wire which surrounds the piece of soft iron when the latter becomes a magnet through the influence of the inducing magnet, N (the same takes place when we take the piece of iron away from the influence of the inducing magnet, as is well known), and that the inducing magnet, N, has no influence upon the insulated conducting-wire. In fig. 2 we have seen that the inducing magnet, N, takes the most active part in the generation of currents in the insulated conducting-wire.

If the magnet is feeble in magnetic power, and the piece of soft iron thick, then the current is generated through the inductive influence of the inducing magnet only, but when the inducing magnet is of great magnetic power, then the soft iron will assist in the generation of currents after its double polarity has changed to one polarity.

In fig. 3 we show a soft iron ring armature surrounded by the two inducing magnets, N and S; we see that this is the same arrangement as in fig. 2, but double, and with the iron and inducing magnets made into circular shapes.

Currents can be generated in the insulated conducting-wire surrounding this ring, as described in fig. 2, when the inducing magnets are brought close

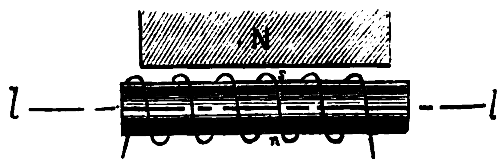


Fig. 2.

to the ring or withdrawn; if, however, the ring armature is rotated within the inducing magnets, then a somewhat different action takes place. Mr. Heinrichs' theory of this action is as follows:—

When the soft iron ring (fig. 4) is rotated between the powerful inducing magnets, N and S, in the direction of the arrows, and we then follow a given portion of the ring armature through the S S inducing magnet up to point p_1, we shall find that the soft iron ring has at this point acquired north polarity throughout the whole section by the continued influence of the inducing magnet, S, and a current will be generated in the whole length of the insulated conducting-wire surrounding that part of the ring, this current being wholly in one direction; this will therefore be the most favourable point of the armature for the generation of currents. If we follow that portion of the ring further on we may say that at the point p_2 the condition of the armature is still the same as at point p_1, but at point p_3 that portion of the ring now comes under the feeble influence of the N inducing magnet, and will have to change its polarity from north to south, which it will do on the outer surface only, as the demagnetisation of the iron ring does not take place at once, and, as we have seen in fig. 2, the piece of soft iron, when coming under the influence of the N inducing magnet, acquires at first south polarity on the surface nearest to the inducing magnet and north polarity on the opposite surface;

thus when this part of the soft iron ring (fig. 4) comes at point p_3 under the influence of the N inducing magnet, it will then still be assisted by the inducing magnet, N, in retaining north polarity on the inner surface of the soft iron ring. The current generated in this part of the armature will be greatly weakened by a powerful current set up in a reverse direction to the former in those portions of the insulated conducting-wire surrounding the inner reverse polarity of the ring, and heat will be produced in the conducting-wire. If we follow that portion of the ring to point p_4, we see that the inner reversed polarity of the iron ring becomes overpowered in proportion as the influence of the inducing magnet increases, and from here the current generated by the influence of the inducing magnet, N, and the south polarity of the soft iron ring, takes the lead and gains on points p_5 and p_6, and at point p_7 the whole section of the ring armature will have acquired south polarity. In this case the current in the whole length of the insulated conducting-wire surrounding that portion of the ring will again be in one direction only, and the current will be generated by the united influence of the N inducing magnet and the south polarity of the soft iron ring. Thus we see that the inducing magnets take the most active part in the generation of electric current in the insulated conducting-wire which surrounds the soft iron ring, though they are assisted by the latter. Further, the double polarity of the soft iron ring in the section gives an impulse to the production of currents of great strength which are generated in a reverse direction to the main current. These reverse currents become neutralised by the main current, which weakens the latter to that amount and causes great heat to be developed in the insulated conducting-wire. The main current consists of two halves, one of which is made up of the sum of all the electric currents generated in one direction in those insulated conducting-wires which are at a given time under the influence of the N inducing magnet, and the second half is made up of all the electric currents generated in a reverse direction to the former in all those portions of the insulated conducting-wire which are at the same time under the influence of the S inducing magnet. Both currents are taken off by the brushes in one direction, and form, together, the main current. The neutral lines which are shown in figs. 2 and 3 through the centre of the soft iron, as dividing the two polarities, take the shape of curves when the iron ring is rotated within the inducing magnets, N and S, fig. 4. The form of the curves will depend on the different conditions of the soft iron ring and the inducing magnet. If the soft iron ring is very thick, and the inducing magnets feeble, the curves will be long, as the demagnetisation of the reverse polarity on the inner surface of the iron ring takes place very slowly, and if the soft iron ring is very thin and the inducing magnet powerful, then the curves will be shorter, as the demagnetisation of the reverse polarity of the iron takes place quickly.

The speed at which the armature is rotated will also produce different curves: the quicker the speed the longer the curve.

The proper place at which the brushes should be set to collect the currents from the commutator will correspond to the place on the curves where the inner reverse polarity of the iron ring becomes less than the outer polarity. This, again, depends upon the thickness of the iron ring, the power of the inducing magnets, and the speed at which the armature is rotated. A thick iron ring will show on the inner surface a great reversed polarity, while a thin wide ring will acquire quickly one polarity in the section, but it will also help less in the generation of currents, and will thus act chiefly as a screen to the insulated conducting-wire surrounding the inner surface of the iron ring.

M. A. Breguet came to similar conclusions when describing the Gramme ring, and he gives to the soft iron ring the *rôle* of a screen (see fig. 5), which we reproduce from his pamphlet, "La Machine de Gramme." The dotted lines represent the lines of magnetic force radiating from the two inducing magnets, N and S, and attracted from the soft iron ring; the more intense lines of magnetic force are marked *m*, and the less intense are marked *n*. We see that the inner surface of the soft iron ring is fully screened from the lines of magnetic force of the inducing magnets, N and S; but we cannot find that M. Breguet has paid any attention to the fact that the iron ring acquires magnetic polarity and then takes part in the generation of the current. We have seen from Mr. Heinrichs' explanation in figs. 2, 3, and 4, that the iron ring in whatever form it be will assist in the generation of the current if powerful inducing magnets are employed, as is actually done in dynamo-electric generators. Pacinotti* made his original soft iron ring solid, and round in section, recessed on the circumference for the reception of the insulated conducting-wire (fig. 6), and weak magnets ineffectively arranged were employed for inducing; the results obtained with his generator were consequently but feeble in comparison with those of the generators now in use. This will be easily understood from the foregoing explanation. M. Gramme makes his ring thin and wide (fig. 7), and instead of solid iron he employs a bundle of thin iron wire; then M. Gramme reduced the *rôle* of the ring in the production of currents and left it mostly to the inductive influence of the inducing magnets; nevertheless, in this form of ring, the production of reversed currents, and consequent heat in the armature, are not got rid of, as the ring made out of a bundle of iron wire will yet have to pass through all the stages described in fig. 4.

The foregoing explanations must lead us to the question, Why not leave the inner part of the iron ring out and take the insulated conducting-wire away from its influence? for, as we have seen in fig. 4, the outer surface of the iron ring acquires the magnetic polarity in the right order. This has been done by Mr. Hefner von Alteneck (Siemens), who gave the ring armature the form of a cylinder (fig. 8), and wound the insulated conducting-wire on the outer surface of the cylinder only by crossing the diameter of the cylinder at the two ends. The results obtained with this form of armature were proved, by Mr. Douglas, to be superior to those obtained with a Gramme ring, in experiments made at the South Foreland.†

The coiling of the insulated conducting-wire on

* See *Telegraphic Journal*, vol. vii, p. 217.
† See *Telegraphic Journal*, vol. v, p. 257.

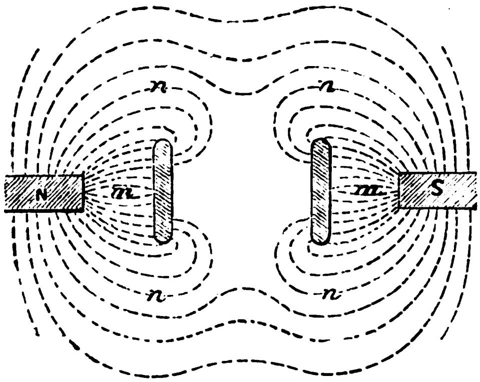


FIG. 5.

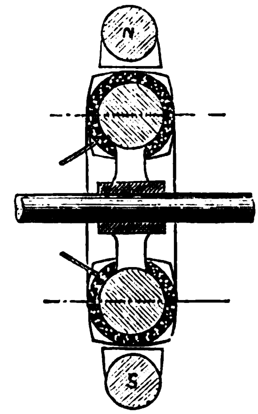


FIG. 6.

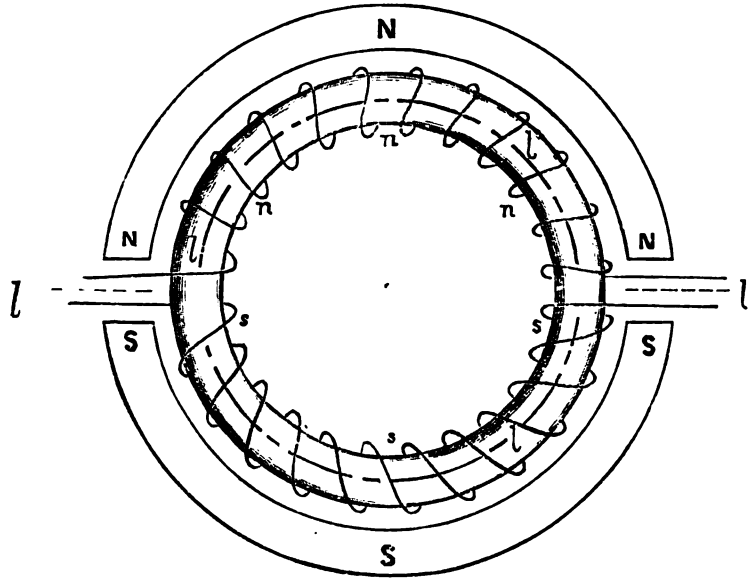


FIG. 3.

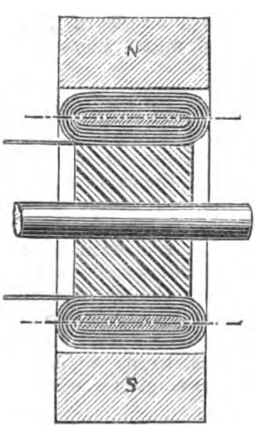


FIG. 7.

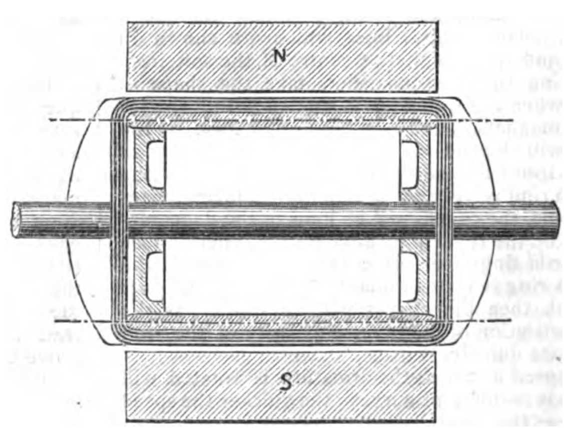


FIG. 8.

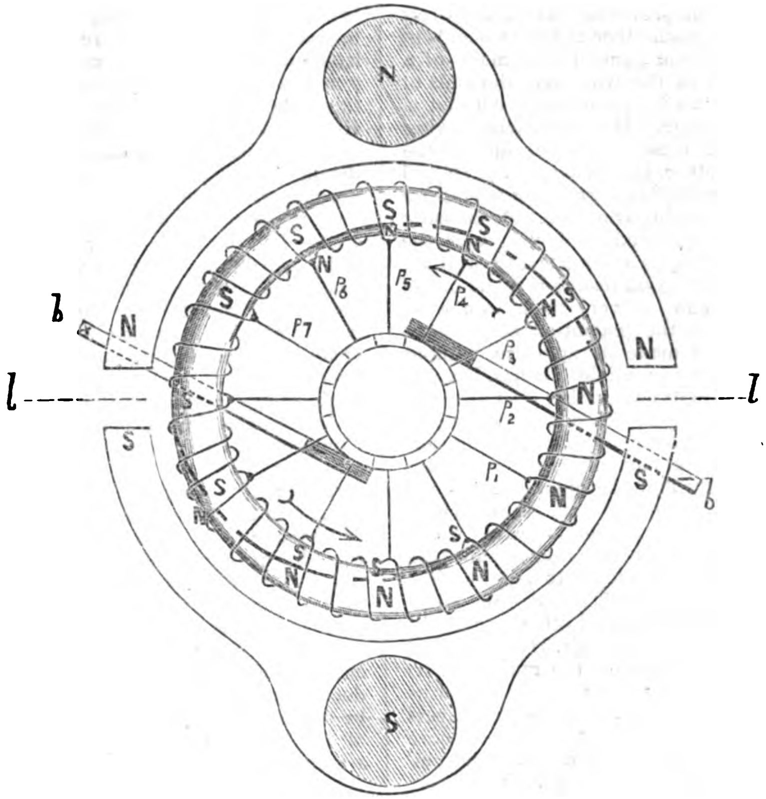


FIG. 4.

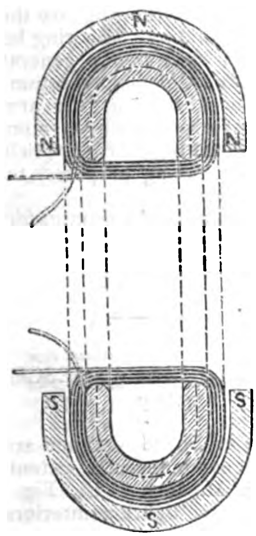


FIG. 10.

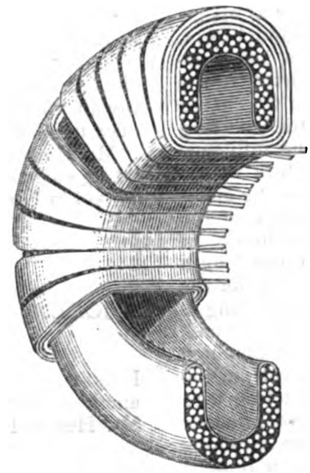


FIG. 9.

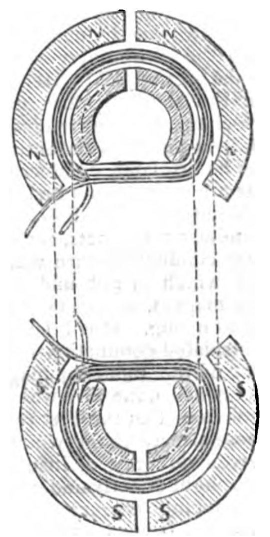


FIG. 11.

the ends of the cylinder is still not very satisfactory, the accumulation of heat on this part of the armature cannot be prevented, as all the wires of the armature cross each other at the two ends of the cylinder; and if the generator is made of a large size the length of the wire over the ends of the cylinder is increased considerably without a corresponding advantage. Mr. Heinrichs having satisfied himself on all these points, has adopted the channelled ring armature, shown by figs. 9, 10, and 11, the insulated conducting-wire being wound on the outer surface of the ring armature. By crossing the channel with the insulated conducting-wire the inner surface of the ring is not made use of at all. This armature will give good results if made out of solid iron, or a bundle of very thick iron wire, which assists greatly in the generation of currents. This armature can be made in any size without altering its advantageous principle. It has, besides, one very great point in its favour, that is, it prevents the accumulation of the heat which is naturally produced in the insulated conducting-wires when they are traversed by powerful currents; this takes place also in all armatures through the quick changes and enforced demagnetisation of the iron. In Mr. Heinrichs' ring, the insulated conducting-wire which crosses the channel is freely exposed to the air, both inside and outside. This also tends to keep the iron ring cool and to maintain the efficiency of the armature. This is a point we miss in all other armatures.

In the early part of last year Mr. Heinrichs had occasion to rewind a bobbin of the multiple current generator of a Lontin machine, and he informs us that he found the insulation of those four layers of copper wire which were nearest to the iron core totally burnt; this is prevented in Mr. Heinrichs' new armature, where the wire which is the nearest to the core has a considerable portion of its surface exposed to the air, *i.e.*, where the insulated conducting-wire crosses the channel. In fig. 10 we see this ring armature in section, made in horseshoe or channel form, the inducing magnets, N and S, surrounding the entire outer surface of the horseshoe ring in the section. Mr. Heinrichs claims as his invention the ring armature made in channel form, over which the inducing magnets, N and S, are so arranged as to surround the entire outer surface of the ring. The insulated conducting-wire in which the currents are to be generated overlies the iron ring only where the ring is directly under the influence of the inducing magnets, thus, that portion of the insulated conducting-wire which crosses the channel, and which is not under the influence of the inducing magnet, is also not under the influence of the soft iron ring. It will be seen that the length of the insulated conducting-wire which is under the influence of the inducing magnet and iron ring is much longer than the wire which crosses the channel.

It is obvious that the best results will be obtained with those armatures in which the largest portion of a given quantity of insulated conducting-wire can be brought directly under the inductive influence of the inducing magnets. Thus, if the Gramme ring (fig. 7) is made 5 inches wide it will have only 5 inches of insulated conducting-wire under the inductive influence of the inducing magnet (those which overlie the outer surface of the ring), against 5 inches of insulated conducting-wire, screened by the iron ring from the influence of the inducing magnets, as shown in fig. 5, and where no currents are generated. In the Hefner v. Alteneck armature the cylinder is 10 inches long and has a diameter of 7 inches; thus we find there are 10 inches of insulated conducting-wire for current generating against 7 inches of wire which do not generate any current; this shows favourably against the Gramme ring. In Heinrichs' horseshoe ring the proportions are 10 inches of insulated conducting-wires for current producing against 4 inches of wire which are not current producing, and these 4 inches are arranged so as to help to keep the whole insulated conducting-wire cool. These figures show the advantage of Heinrichs' armature. In fig. 11 we show a further modification of Mr. Heinrichs' channelled ring, which is here nearly round in section, as in the original Pacinotti ring, but in which his principle of having a channel and employing surrounding inducing magnets is adopted. In another article we hope to describe the generator and the results obtained with it.

As we have shown the most developed form of ring armature in this article we have yet to draw attention briefly to two more modifications of the arrangement, namely: where the ring has been made as a flat narrow ring, and the inducing magnet arranged on both sides of the ring. The priority of this idea belongs to Mr. Schuckert,* as it was introduced in his generator over five years ago. Several of his machines have been in use in this country. The soft iron ring is made out of thin sheet iron plates which acquire little magnetism and act chiefly as a screen, as in the Gramme ring. The demagnetisation of the iron ring is much assisted by having inducing magnets arranged on both sides of the ring, but it will produce great heat in the armature.

In the Brush generator† the armature is also a flat, narrow but solid iron ring, recessed on its circumference for the reception of the insulated conducting-wire, as in the Pacinotti ring. The position of the inducing magnets, relative to the ring, are the same as in the Schuckert generator. The ring being of solid iron, bears a great part in the generation of the currents. The enforced demagnetisation of the solid iron ring produces heat in the armature. This is to some extent overcome by a number of slots on the circumference of the ring which allow the air to circulate for cooling purposes, but produce noise when in motion.

Mr. Heinrichs' new means and apparatus for generating electric current were patented in England and abroad in November, 1879.

JOEL'S IMPROVED INCANDESCENT ELECTRIC LIGHT LAMP.

FIGS. 1 and 2 show an improved form and arrangement of electric light lamp recently patented by Mr. Henry F. Joel, A. M., Inst. C. E. Fig. 1 is a complete lamp suitable for lighting interiors, and fig. 2 is an enlarged section.

The improvements made in this form of electric light are mostly mechanical details, and make the

* See *Telegraphic Journal*, vol. vii., p. 118.
† See *Telegraphic Journal*, vol. vii., p. 21.

lamps more practical and suitable to take the place of gas fittings, the arrangement for turning the light on or off being similar to the action of gas lamps. The most important improvement is the method of making good electrical contacts, whilst the action of the lamp, in comparison with other similar lamps, is much simplified. The weight, W, that presses the carbon pencil electrode through the jaws, J, to the terminal electrode, E, also at the same time presses the two jaws, J, on to the pencil; this is effected by using bell crank-shaped jaws, J, the weight acting by means of the rollers, R, cord, and tube with flange, on to the upper or horizontal

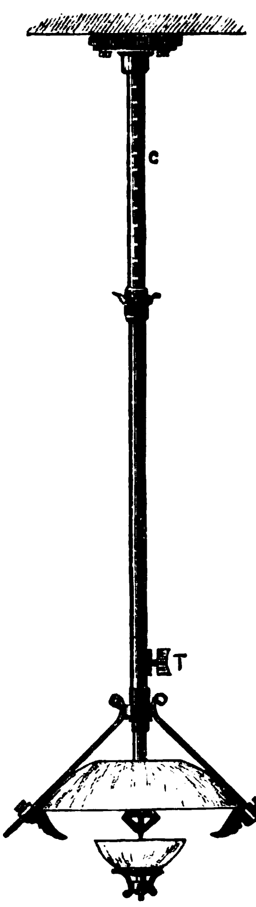


FIG. 1.

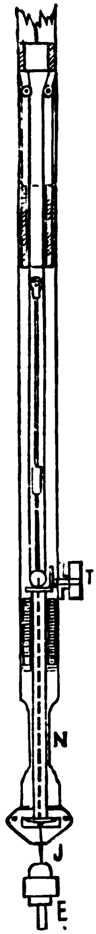


FIG. 2

arms, which being pointed, clamp the carbon pencil electrode in the inclined jaws; the cord suspending the weight, W, also passes through a roller at the end of the pencil electrode holder, and presses that electrode through the jaws, J, by varying the lengths of the horizontal and inclined arms of the jaws.

The pressures can be varied so that with a weight of, say eight ounces, seven ounces can be absorbed in lateral contact, and leaving only a resultant one ounce forward or feeding pressure of the carbon pencil against the terminal electrode; this regulation saves about 20 per cent of the carbon pencil. As the fine coned point made by the current is not broken off, there is also a gain in economy and power of light on this account.

A further improvement consists in arranging a tap, T, as a switch or cut off on the side of the lamp, the act of turning off the light putting an equivalent carbon resistance, C, shown at top of the lamp, fig. 1, in dotted lines, in circuit, thus rendering each lamp independent, whilst the turning of the tap at the same time opens the jaws, J, ready for a fresh supply of carbon, and by short circuiting the lower part of the lamp removes all chance of danger whilst putting in fresh carbons. There is also a special arrangement of shunt circuit coils for use when a great number of lamps are joined in one circuit, whereby the most delicate contact can be maintained between the electrodes with perfect safety. These and other minor improvements render these lamps especially suitable for lighting interiors, and we must congratulate Mr. Joel for his really practical efforts to render electric lighting easy and capable of being generally adopted.

THE PHOTOPHONE.

FROM advices recently received we understand that Professor Graham Bell has been experimenting on his photophone in Paris with very satisfactory results. The electric light has been employed, and this is found to give out a peculiar sound of its own. The articulation of the speaker is superposed upon the irregularity of the light—like the voice of a telephonist upon the irregular currents due to induction and leakage. Several new experiments have been made by Professor Bell to confirm his theory that the discovery is a new property of matter. In the experiments made in America all the substances tried were formed into thin diaphragms, but Professor Bell has devised a new form of experiment, by which substances of all kinds can be tried. The substance is inclosed in a test tube, the open mouth of which is connected to a hearing tube. By this arrangement liquids and gases, as well as solids, can be tested.

The relative effect of light upon the substances tried was as follows, the test tube being submitted to the action of an intermittent beam of light:—

	Substance.	*Form.*	*Result.*
1.	Bichromate of Potash	Crystals	Good sound.
2.	Iodide of Potassium	,,	,, ,,
3.	Chlorate ,,	Powder	No ,,
4.	Selenium	Vitreous	Good ,,
5.	,,	Crystalline	,, ,,
6.	Sulphur	Stick	,, ,,
7.	Sulphate of Copper	Crystals	,, ,,
8.	,, Zinc	Very pure crystals	Feeble ,,
9.	Paper	Small piece coiled up.	,, ,,
10.	Ebonite	Hard rubber	Very good sound.
11.	Carbon	Rod used for electric light.	,, ,, ,,
12.	Brass	A binding screw	Feeble ,,
13.	Alum	Powder	,, ,,
14.	Camphor	,,	,, ,,
15.	Borax	,,	,, ,,
16.	Tartaric Acid	,,	,, ,,
17.	Carbonate of Magnesia	,,	,, ,,
18.	Chalk	,,	,, ,,
19.	Wood	Some chips	Very good ,,
20.	Smoke	From a cigar	,, ,, ,,
21.	A whole Cigar		,, ,, ,,
22.	A Lead Pencil		,, ,, ,,
23.	Water		No sound.
24.	,, discoloured by Ink		Very feeble sound

It will be noticed that in cases 3 and 23 no sound at all was heard.

Amongst other discoveries Professor Bell has found that melted sulphur conducts electrically like selenium. When flowers of sulphur are melted the fluid conducts fairly well. The conductivity increases with rise of temperature until that temperature is reached when the liquid begins to change colour. When it has become of dark orange colour all trace of conductivity vanishes, and the substance after this cannot be made to conduct by cooling and re-heating. Whether the substance has its electrical conductivity affected by light has not yet been determined.

ELECTRICAL INTER-COMMUNICATION IN TRAINS.

By G. K. WINTER, F.R.A.S., M.S.T.E.,
Telegraph Engineer, Madras Railway.

AMONGST the numerous applications of electricity, the rapid communication of intelligence from one place to another is that which has received the greatest development, and it is certainly the use to which this wonderful agent appears to be most specially adapted. In the early days of its employment for this purpose it was thought uncertain and capricious, but as time went on difficulties one after another disappeared; its action, before uncertain, became more and more under control, and its very caprices have been found subject to law, and have been converted into some of the most useful of its attributes.

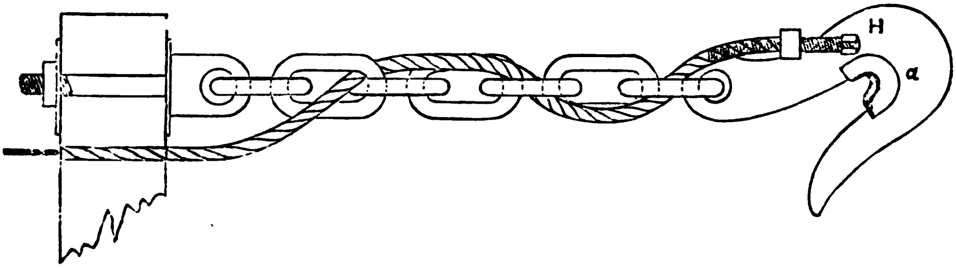


FIG. 1.

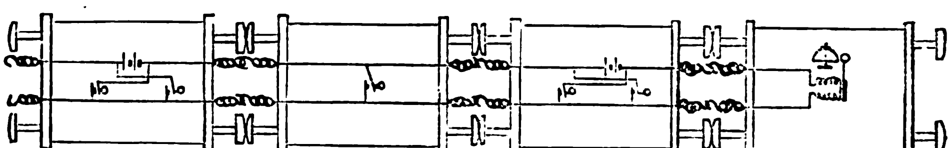


FIG. 2.

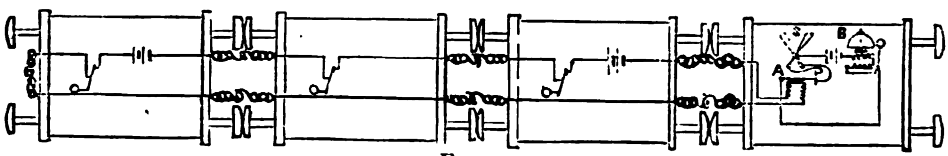


FIG. 3.

Inter-communication in trains, or the communication of intelligence from one part of a train to another, has received a large amount of attention, and much ingenuity has been devoted to the solution of the problem. The fact, however, that no system has been universally adopted would tend to show that no system hitherto brought forward is practically perfect. Captain Tyler has said that electricity offers the best promise of success, and in this view most men acquainted with the present state of electrical science would probably concur.

In looking carefully into the question of the merits and demerits of the various existing electrical methods, with a view of discovering the best system for adoption on the Madras Railway, I found that the use of the wheels and rails as an "earth" or return circuit, and the use of special electrical couplings, were nearly universal. A few experiments were sufficient to convince me that in India, at least, we could not make this use of the wheels and rails; for even supposing the electrical contact between the framework and the axles to be perfect, that between rail and rail could not be relied on, especially in dry weather; and with regard to the special electrical coupling, a little consideration was sufficient to show that any system which involved any extra labour or attention in forming or shunting trains, was unsuitable to our mixed and ever changing traffic. There seems also to be little doubt that any difficulties which have been found to attend the application of the electrical systems hitherto proposed have been due to negligence or forgetfulness in forming the extra coupling, or to the imperfect earth formed by the wheels and rails. A coating of snow, for instance, over the rail would destroy

communication even in England. The motion and consequent vibration of a train, on the contrary, presents no difficulty which cannot be easily overcome.

My endeavours have therefore been directed to the adaptation of the existing couplings to the purposes of communication, and to doing away with the necessity of using the wheels and rails as an earth. The result is a system which has been well tried on the Madras Railway, and has, I believe, given satisfaction to all who have seen it. It is impossible for any mistake to be made by the porters in forming or shunting a train, for they have only to do the work they have been always accustomed to, and it is impossible for any quantity of dust, tar, dirt, or grease, on the surfaces of the hooks to damage in the slightest degree the integrity of the circuit, for the hooks are self-cleansing, and the weight of the chains is sufficient to insure the perfection of the contact.

Having abandoned the use of the wheels and rails as an earth, we require two conductors, insulated from each other, running from one end of the train to the other. This is simple enough as far as the carriages themselves are concerned, but the most difficult as well as the most important point is the mode of connecting electrically the conductors of one carriage with the corresponding conductors of the next. This connection I accomplish by means of the side or safety chains in the following way:

A strong and flexible cable is passed through the links of the chain; the conductors of this cable form a continuation of one of the insulated conductors of the carriage, and are fastened electrically to the hook at the end of the chain.

The cables are made by winding galvanised iron binding wire, weighing about 100 lbs. to the mile, helically round 1½ inch tarred hemp rope in the grooves between the strands. The end of this cable, which is to be attached to the hook at the end of the chain, is close bound with the same binding wire for a length of about 3 inches, and the ends of the wires projecting beyond the hemp rope are twisted together into a wire rope.

Two holes are drilled through the shank of the hook about 1½ inches apart, and into these holes tinned iron eye bolts are soldered. The ring of the eye bolt nearest the end of the hook is only large enough to admit the wire rope projecting beyond the cable, while the other is large enough to admit the cable together with the extra binding. The bound end of the cable is passed through the large eye bolt and carried as far as the small one, through which the wire rope is passed, and to which it is firmly soldered; the rope is then unwound and spread radially over the ring of the bolt, and again firmly soldered on to its surface, the ends of the wire being cut off if too long. The lower end of the cable being thus firmly fastened to the shank of the hook, the cable is passed through the links of the chain in the most convenient manner, and finally passed through a hole in the buffer plank of the carriage, the wires of the cable are then soldered to the end of one of the wires running underneath the vehicle. The chain and cable are well coated with tar, except on the inner surface of the hook.

The next point to be considered is the best mode of securing good electrical contact between the hook of one chain and that of the next carriage, when they are coupled. On the electrical condition of this contact depends the success or failure of the system, I have therefore spared no pains to insure its perfection. The shape of the ordinary coupling hook has been slightly altered, so that the inside curve is more of a V shape than formerly. The hooks are made red-hot, and are easily altered into the required shape by first driving a die between the jaws of the hook, and then completing the alteration by means of the hammer, keeping the die in its place during the operation. The bearing surface of the hook is then coated with a piece of sheet copper which is brazed on, and finally a small rib of gun-metal of semi-circular section is soldered on to the inside of the outer jaw of the hook. Fig. 1 is a drawing of a complete chain with cable, &c.

It has been found that with hooks prepared as above, neither grease, tar, nor dust, are able to impair the contact of hook with hook, and the small stones, which are occasionally thrown upon the chains from the ballast, are unable to insinuate themselves between the acting surfaces.

The method of working adopted on the Madras Railway is very simple, and might be still further simplified could a battery be conveniently placed on the engine.

A battery is placed in each brake van, and all batteries are so connected that they always tend to send a current in the same direction. The circuit is always open except when closed by pressing a plunger in the act of signalling. The disposition of the apparatus in a train will be understood from fig. 2.

All that is necessary is to have a brake van between the passenger carriages and the engine, and even this rule would be rendered unnecessary if we could place the battery on the engine, instead of in the vans. This system has been working exceedingly well on the Madras Railway since the 1st January, 1879, the daily train mileage worked being about 1,776 miles. The fitting of the whole stock of the railway is being rapidly proceeded with, and at an early date the whole of the trains running on the railway will be provided with an efficient means of communication between the guards and passengers and the driver. The arrangements are tested on leaving or passing through each station by the guard in the rear van giving an all-right signal to the driver, and any failure or irregularity in the working of the apparatus is entered is the guard's and driver's journals, and is reported to the heads of their respective departments, so that the letters that have been given me by the traffic manager and locomotive superintendent are written with full knowledge of the manner in which the system has worked.

It has not been thought necessary hitherto to apply a break-away signal to the system on the Madras Railway, and the author does not recommend its adoption, owing to the complication necessarily involved; it can, however, be applied in several ways, of which the following arrangement, shown by fig. 3, is probably the cheapest, simplest, and most easily applied.

The closed circuit is used, and signals are made by breaking or opening the circuit, so that if a train parts a signal is given automatically in consequence of the break in the circuit, caused by the parting of the train. The difficulty which has hitherto prevented this system from being adopted is, that

during shunting, or when the engine is separated from the train, the engine bell would be continually ringing, unless some act were performed to stop the ringing, and in this case there is always the danger of the apparatus not being re-adjusted for ringing when the train is made up again. The difficulty I propose to overcome in the following simple manner.

A relay is used on the engine to complete the circuit of a local battery through the bell. This relay has two contacts, the armature making contact with the one when the train circuit is complete (that is, when the constant current is flowing through the coils of the relay), and with the other when the train circuit is broken (that is, when no current is flowing through the relay coils). A switch attached to the apparatus is arranged to join one contact with the battery and bell when the switch handle is in one position, and the other contact with the battery and bell when the handle is in its other position. Thus, suppose when the train is joined up, and the train circuit closed, the bell is silent when the switch handle is at A, and that it rings when the handle is at B, then, when the train is divided, and the train circuit broken, the bell will be silent when the handle is at B, and it will ring when the handle is at A. Thus on arriving at a station at which shunting is to be performed, directly the train is divided the bell will ring, and will continue to ring until the driver turns the handle to B. Again, when the shunting is completed, and the train joined up again, the bell will ring until the driver turns the handle back to A, so that whether the train is being formed or broken the driver is reminded of the change to be made in the position of his switch handle by the ringing of the bell, and there is consequently no chance of the proper adjustment being forgotten. The arrangement is shown in fig. 3.

It will be seen that signals may be given to the driver by simply dividing the circuit in any part of the train, and keys arranged to do this may be fixed in any or all of the vehicles. Also, should any part of the train become separated, the act of separation will break the train circuit and cause the bell to ring.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XX.

LIGHTNING PROTECTORS—(*continued*).

FIG. 77 shows a form of lightning protector which is used to some extent in the Postal apparatus, it is known as "Varley's Vacuum" protector. Its principle is based on the fact that an ordinary battery current, such as is used for working telegraph instruments, will not jump between two points set close together, even though the latter be surrounded by a partial vacuum; a lightning discharge, however, will follow the nearest path open to it, although that path be of infinite resistance to a current of low tension, and will "strike" across an air space with great ease, and with still greater ease across a partial vacuum. In Varley's protector two metallic points, p_1, p_2, fixed at the ends of platinum wires are inclosed in a small glass bulb, the wires being fused into the glass so as to make an air-tight joint. The bulb is exhausted of air, and then the aperture through which the exhaustion is effected is sealed up. The ends of the platinum wires are screwed into brass collars, A, B, by means of which the protector is secured in the instrument it is required to protect. Square openings are made in A and B which fit over square brass pieces, and then large flat-headed screws are screwed down into the latter, and thus A and B are secured. The object of making the openings of a square shape is to prevent the heads of the securing screws from twisting A and B round when the former are nearly home; if this twisting took place the platinum wires would get bent and perhaps broken in the glass.

The protector may either be used as a bridge between the Up and Down line, as at an intermediate station, or one end may be connected to the line and the other end to earth; this would be done at a terminal station.

One advantage of this form of protector is that it cannot cause a contact fault in the instrument, that is to say, it cannot accidentally connect the Up and Down line or short circuit at an intermediate station, nor at a terminal station can it connect the line direct to earth. These faults, although they rarely occur, sometimes do take place in the brass tube protector (see last article). On the other hand, the vacuum inside the bulb is liable to fail, and although this does not entirely render the protector useless, still it very nearly does so.

The method of testing the protector is to send the discharge from a small induction Ruhmkorff coil through it; if the discharge between the points takes the form of a glow, then the protector is in good order. If, on the other hand, sparks pass, then the vacuum is defective and the protector must be rejected.

It is usual to place vacuum protectors at the terminal poles on a line where the open wires join the underground work. In this case a number of the protectors are inclosed in a water-tight iron box, one of the ends from each protector being connected to the junction of the open wire with the underground wire. The other ends of the protectors are all connected to earth. The lightning on striking the open line wire will leave the latter at the terminal pole and run to earth through the protector, a small portion only passing on through the underground work. These protectors are examined and tested every month.

Another form of protector used to some exent consists of two brass plates about 4 inches square, set face to face and separated by a sheet of paraffined paper. Formerly it was usual to plough the surface of the plates into a number of furrows, those in the upper plate running at right angles to those in the lower plate. It was imagined that the points formed by the crossing of the ridges would be favourable to the discharge, but some experiments made by Mr. W. H. Preece (TELEGRAPHIC JOURNAL, Vol. VII., page 294) proved that the supposition was a fallacy, and consequently plates with smooth flat surfaces are now employed.

The protection of cables from lightning is a point of the highest importance, and as all the cables in

the Postal Department are connected to land lines of considerable length they are peculiarly liable to damage. The form of lightning protector placed on the huts in which the cables land is shown by fig. 78.

This arrangement consists actually of two protectors, one of the ordinary plate form and the other of a brass reel connected to earth, and around which is wound a fine insulated platinum wire, which is connected between the open wire and the cable.

The open wire is connected to terminal A, while

The brass reel, R, after being wound (in a single layer) with the fine platinum wire, is dipped bodily into melted paraffin wax so as to keep out moisture.

If the lightning strikes the line wire it has an alternative route to earth through the plate protector, or to earth through the fine wire and the brass reel by striking through the insulating covering of the wire. If the discharge is powerful the platinum wire becomes melted, thus severing the cable from the line.

After every thunderstorm it is usual to examine the protectors at the cable huts to see whether they

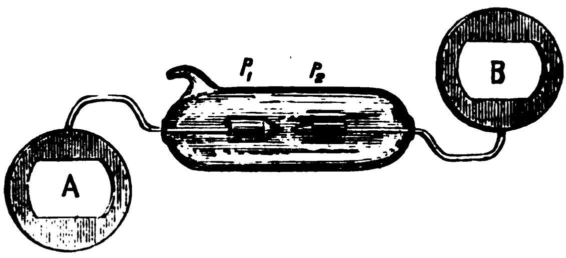


Fig. 77

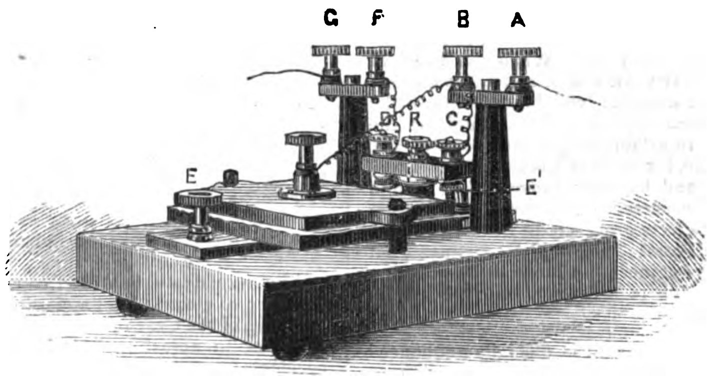


Fig. 78.

terminal B is connected to terminal C, the latter being attached by the lower end of its stalk to one end of the fine insulated platinum wire wound around the metal reel, R.

Terminals A and B are mounted on an ebonite pillar to insure good insulation, and terminal B, in addition to being connected to terminal C, is also connected to the upper plate of the plate protector.

The lower plate of the latter is extended beyond the upper plate, and on it is screwed the brass reel, R, before referred to. The extreme ends of the plate have terminals E, E′ screwed into them, to which earth wires are secured.

The other end of the platinum wire is secured to the lower end of terminal D, which latter is connected to terminal F, and then by terminal G to the cable.

are in good order. It is often found that the paraffined paper has become perforated by the discharge; it has then to be renewed.

Messrs. L. Clark, Muirhead & Co.'s new offices at Regency Street, Westminster, were lit a few evenings ago by eight of Mr. H. F. Joel's new electric lamps (*see* page 364). The lamps burned without the slightest variation. One lamp lit up a room 16 ft. by 12 ft. perfectly. The eight lamps were driven from ordinary A Gramme, worked from an engine used for all the lathes and machinery, &c. The eight lamps were in one circuit of about 250 yards.

Notes.

THE FIRE AT THE MANCHESTER TELEGRAPH OFFICE.—A most destructive fire broke out on Sunday night in the Manchester Postal Telegraph Office. How it originated has not been ascertained. The fire first occurred in a lift. On ordinary days there are about 400 clerks employed on the premises, but on Sundays only about a dozen clerks are on duty. Before the fire brigade could get to work the flames had got strong hold, notwithstanding that the clerks in the office had made every effort with the appliances at hand to keep them under control. The firemen, however, soon obtained a mastery over the flames, and there does not seem to have been much harm done to the building, but the whole of the telegraphic communication had been severed, and for some hours Manchester was entirely isolated; the insulating covering of the wires had been melted with the great heat, and scores of wires were massed together like a rope. There are from 270 to 300 wires running into and through the office. Every one of these was blocked, and it required the greatest care to ascertain how the severed communication could be restored. London was amongst the first places to suffer, and a number of towns were also cut off in a moment. All the battery wires and all the line wires were destroyed. Of course the best arrangements that could be were made. Other towns were aware of the interruption which had been caused, and they made the best arrangement possible. Messages for Manchester were sent to Liverpool, the nearest receiving office, and were thence despatched to the former city by train, where a body of messengers was organised to meet the train and deliver the telegrams. When the fire had been mastered the next work was to restore communication, and at this task all the available strength of the engineering department was directed throughout the day. This work of re-establishing communication was most effectively done, for in less than 24 hours every circuit was restored and business proceeded as though no interruption had occurred. The speedy restoration of communication reflects great credit not only on the organisation of the Postal Telegraph Department, but on Mr. Doherty, the engineer in charge in Manchester, and on his staff. There were 257 circuits broken down altogether.

THE *Pall Mall Gazette* says it is officially announced to-day (Oct. 26) that an International Congress of Electricians will assemble in Paris on the 15th September, 1881. It will be preceded by an international exhibition of electrical apparatus and appliances, to be held from the 1st to the 13th of August of the same year.

TELEGRAPHIC communication between Durban and the Cape Colony is interrupted, the land lines having been broken by the Basutos.

UNDER the name of "an electric hammer," Messrs. Siemens and Halske, of Berlin, have lately patented an arrangement which consists essentially of three coils and a hollow rod of iron or soft steel, which can move to and fro within the coils in the direction of their axis. By means of a constant current, of unvarying direction, sent through the middle coil, the rod is magnetised; and through the other coils a machine or battery sends alternating currents, by virtue of which the rod is alternately drawn in and thrust out with great rapidity. The motion on one side is limited by a spiral spring working an elastic cushion. With a screw arrangement the rod [illegible]ked with the necessary step-by-step rotation in boring rock. When the boring in rock has gone so far that the borer no longer reaches the rock, one of the rod-guiding projections on the upper coil is struck, and this has the effect of displacing all three coils in their stand, wherein they are held fast only by friction.—*English Mechanic.*

THE name of the author of the paper on "The number of electro-static units in the electro-magnetic unit," read before the British Association, at Swansea, and published in our last issue, was accidentally misspelt. It should have been "R. Shida."

PUBLIC interest in telephones appears to be gaining ground. The Gower-Bell Company, whose instruments have been adopted by the Government Departments, are said to have received, in the two months since their registration, applications relating to more than £40,000 worth of telephone outfits.

MESSRS. PATEY and GRAVES of the British Postal Telegraph Department have left London for Paris to inquire into the working of the Pneumatic Tube system as worked by the French Administration in Paris.

AN extremely valuable contribution to magnetic science has just been published by the Royal Society—Mr. M. W. Ellis's paper on the relation between the diurnal range of magnetic declination and horizontal force, as observed at the Royal Observatory of Greenwich, where he is the Superintendent of the Magnetical and Meteorological Department, during the period from 1840 to 1878. He proves incontestably that these magnetic elements are subject to periodic variations coincident with the eleven-year sunspot period, and that sudden outbursts of sunspot and magnetic energy are simultaneous.

WE have always considered that Electro-metallurgy has a great future before it in the direction of the reduction of metallic ores by electricity. The first step in this direction seems to have been taken in America. A company by a patented process proposes to reduce all classes of rebellious ores, except those containing lead, at an expense of three dollars per ton.

ANOTHER death has been caused by the incautious handling of electric light apparatus. During the recent trial trip of the Czar of Russia's new yacht, the *Livadia*, a stoker in adjusting one of the Jablochkoff lamps, accidentally completed the circuit through his body, and was immediately struck dead by the current.

RECENT advices from Melbourne demonstrate that the electric storm of the 11-14th August last occurred simultaneously at Melbourne and at Kew.

WE have received a specimen of a new gas heating burner invented and constructed by Mr. Fletcher of Warrington. The burner is undoubtedly the most perfect of its kind yet invented. The flame is solid, and is stated to give a duty higher than the calculated theoretical maximum for the gas consumed.

THE Brush Electric Light Company, of New York, have opened offices at 860, Broadway, and the officers expect that before the end of October a large number of lights will be in operation in the vicinity of Madison and Union Squares. Negotiations for a building near Madison Square, in which to place the engines and other machinery, are about completed. In the district to be illuminated there are many public buildings, restaurants, and stores. It is said that no attempt has been made to subdivide the light for use in private dwellings,

but for lighting large areas the Brush system is entirely successful. The Brush Company of New York is distinct from the general company having its head-quarters in Cleveland. The New York company was recently incorporated, and holds the privilege of using the Brush light on Manhattan island only. The officers of the new company are: president, W. L. Strong; vice-president, A. D. Juilliard; secretary and treasurer, A. A. Hayes, jun.; general manager, C. M. Rowley.—*Scientific American*.

THE Municipal Council of St. Petersburg is at present deliberating on a proposition made by the Electrotechnik, a Russian society recently established, for illuminating with Siemens lamps the Newsky Prospect, whose length is 7,000 metres.

THE introduction of the electric light, says the *Operator*, on the wharves at Montreal, Canada, has caused a wonderful revolution in the business of loading and unloading vessels. Previous to the adoption of the new method of illumination an ocean steamer usually remained in port from three to four days, whereas under the present system a saving of at least forty-eight hours is effected. As an instance of rapid work the case of a recent Allan mail steamer, the *Scandinavian*, may be cited. This vessel arrived in port at 4.30 p.m. one day, discharged her cargo, re-loaded, and set sail at 1.30 p.m. on the day following —just twenty-one hours afterward.

THE Salford Corporation contemplate promoting a bill in Parliament for powers to supply the electric light.—The town of Akron, Ohio, is to be lighted from lamps on two masts, one of which is 160 feet high.—The Museum of Science and Art, Edinburgh, is now being lit by electricity, as an experiment.—Edison announces that his light has at last passed the experimental stage, and is now ready for public use. To a reporter of a New York paper the inventor stated that in four weeks he should have his shops and eight miles of street lamps in Menlo Park lighted, so that all the world might come and see.

M. BOUTY considers he has proved (*Journal de Phys.*, September) that in simple electrolysis the Peltier phenomenon is produced according to the same laws as at the surface of contact of two metals. It is a purely physical phenomenon without known relations with the heat of combination, or with the latent heat of solution, but connected by a precise law with the thermo-electric forces of corresponding couples. Chemical actions intervene in the production of one or other of the two inverse phenomena merely as disturbing causes, either altering the nature of the surfaces or producing a secondary liberation of heat. They may mask, more or less, the phenomenon on which they are superposed, but they do not produce it.—*Nature*.

HERR HANKEL has recently (*Wied. Ann.*, No. 8) endeavoured to prove the direct transformation of vibrations of radiant heat into electricity. He had formerly shown that rock crystal has thermo-electric polar axes in the direction of its secondary axes (the six successive poles being alternately positive and negative), and he supposes the ether within the crystal to be so arranged that under influence and with participation of the material molecules it is movable in circular paths round the secondary axes, and more easily movable in one direction than in the other. Thus all along a secondary axis the more easily occurring rotation has the same direction, but looked at from without, the direction is opposite at one end to what it is at the other, so giving the opposite modifications of electricity. When radiations from without strike along such an axis, those vibrations in them whose direction coincides with that of the easier rotation of the ether-molecule in the crystal should induce rotation of this along with the material molecule, and at the two ends of the secondary axis there should be electric tensions, with opposite electricity. Herr Hankel verified this by placing an insulated metallic ball connected with a gold-leaf electroscope in the middle of one edge of a rock crystal fixed with its principal axis vertical, while sunlight was thrown from the other side along the secondary axis terminating at the ball; then the arrangement was reversed. The electroscope indicated opposite electricities in the two cases. A gas-flame or a heated ball gave similar effects, which, moreover, were proved to be due to the dark heat rays (not to the luminous rays).—*Nature*.

THE *Boston Herald* gives the following account of an American experiment made on September 2nd:—"A novel exhibition of powerful electric lights was made last evening in the vicinity of the Sea Foam-house, Nantucket Beach, and the display was witnessed by quite a crowd of interested spectators. The Northern Electric Light Company have erected three wooden towers, each 100 feet high, and mounted upon each of these a circular row of twelve electric lights of the Weston patent, each light being estimated at 2,500 candle-power. As these towers are but 500 feet apart and in a triangle, it will be seen that the light of 90,000 candles was concentrated within a limited territory. The design of the exhibition was to afford a model of the plan contemplated for lighting cities from overhead in vast areas, the estimate being that four towers to a square mile of area, each mounting lights aggregating 90,000 candle-power, will suffice to flood the territory about with a light almost equal to midday. Last evening a motive power of thirty-six horses was used in generating the electricity from three Western machines, and the lights, with one single slight flicker, burned steadily and brilliantly all the evening. It is difficult to say whether the experiment proved anything or not. The claim put forward by the company is for an original plan of lighting cities and towns by grouping and elevating electric lights of any kind."

RAPID TELEGRAPHING.—The transmission to Cincinnati on Friday night of the full text of Senator Conkling's speech at the Academy of Music, New York, is worthy of mention. The speech was transmitted by the Phillips system of steno-telegraphy in five hours and five minutes. This is a process of transmission done entirely by hand, and the despatches are received by an ink recorder of great simplicity, which pays out a narrow strip of tape, on which the matter is plainly printed in linear characters. The wire was worked without a "repeater," and the amount of matter transmitted (sixteen thousand words) was fully equal to what would be averaged by the Morse system on three wires, by three senders and three receivers. The speed attained may be more fully realised when it is remembered that Mr. Conkling spoke for three hours and forty minutes, and that his utterances were transmitted in five hours and five minutes, the entire speech being in the Cincinnati *Gazette* office one hour and twenty-five minutes after Mr. Conkling ceased speaking, although he had been talking fifteen minutes when the work of transmission was begun. Despatches transmitted by Mr. Phillips' method require no preparation whatsoever, the operator sending from the manuscript. Steno-telegraphy is the invention of Mr. Walter P. Phillips, the well-known telegraphic expert, now agent of the New York Associated Press in this city. He challenges the inventors and exponents of any and all "phantom

circuit," "automatic," or other known systems of telegraphy, as practised either in this country or in Europe, to equal with one man on a similar stretch of wire the amount of work performed as above described, and he avows his ability to produce a plentiful supply of manipulators who can duplicate this record without difficulty. The inventor further maintains that, by the introduction of steno-telegraphy, press matter can be handled at treble the speed now attained, and consequently at a reduced cost, since the system not only increases the capacity of single wires, but being applicable to "duplexes" and "quadruplexes," renders the former equal to six instead of two, and the quadruplex equal to twelve instead of four wires as at present. The Phillips' system carries every punctuation mark used in printing, italicises all words from foreign languages, names of newspapers, &c., and secures the delivery of copy properly punctuated and edited for the compositor. The art of sending and reading steno-telegraphy can be learned by Morse operators in the course of seven days, while the knack of transcribing the tape can be acquired by non-professionals in from three to five weeks.—*Washington Republican.*

New Patents—1880.

3936. "Shackle and terminal insulators for telegraph wires." J. W. FLETCHER. September 28.

3964. "Magneto or dynamo-electric machines applicable to both generators and engines." P. JENSEN. (Communicated by T. A. Edison.) Dated September 30.

3971. "Dynamo-electric and magneto-electric machines." A. M. CLARK. (Communicated by A. Niaudet and E. Reynier.) Dated September 30.

4005. "Dynamo-electric and magneto-electric machines." E. G. BREWER. (Communicated by A. J. B. Cance.) Dated October 2.

4007. "Magneto-electric apparatus for railway signalling." G. ZANNI. Dated October 2.

4009. "Improvements in obtaining and applying motive-power, parts of which improvements are also applicable to the transformation of power into electricity." J. G. LORRAIN. (Communicated by G. Trouvé.) Dated October 2.

4039. "Improvements applicable to telephones for the purposes of signalling." J. G. LORRAIN. (Communicated by G. Trouvé.) Dated October 5.

4042. "Means or apparatus for recording a ship's course." A. STEENBERG. (Communicated by F. Alsing, H. Sachmann, and C. Dons.) Dated October 5.

4049. "Dynamo and magneto-electric machines." A. W. L. REDDIE. (Communicated by A. Biloret and C. Mora.) Dated October 5.

4116. "An improved method of and means for transmitting electrical currents through conductors or cables, and for facilitating the action of instruments connected therewith." W. R. LAKE. (Communicated by L. Maribe.) Dated October 9.

4129. "Improvements in electrical signalling and indicating apparatus for telephonic or telegraphic purposes." W. R. LAKE. (Communicated by F. Blake.) Dated October 11.

4139. "Safety apparatus for railways." E. GUENDE. Dated October 12.

4141. "An improved bell and whistle in combination, to be employed for call and warning purposes." J. CHESHIRE. Dated October 12.

4191. "Electric lamps." G. P. HARDING. Dated October 15.

4223. "Improved safety alarm apparatus for steam boilers or generators." C. DE PASS. (Communicated by L. A. Guibert.) Dated October 16.

4265. "Dynamo-electric machines." W. R. LAKE. (Communicated by C. A. Hussey and A. S. Dodd.) Dated October 19.

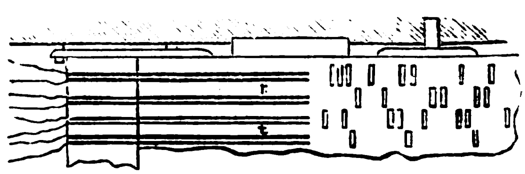
4267. "Improvements in galvanic batteries and process connected therewith." R. C. ANDERSON. Dated October 20.

4310. "An improved magnetic apparatus for separating or removing particles of iron from grain." W. R. LAKE. (Communicated by S. Howes, N. Babcock, and C. Ewell.) Dated October 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

458. "Extracting metals from their ores." W. R. LAKE. (A communication from A. C. Tuhenor, of San Francisco, U.S.A.) Dated February 2. 4d. This invention is based on the discovery that if a current of electricity be applied to the body of the molten metal the rapidity of the fusion of the metal in the ore is greatly enhanced, in fact, so far as to be practically instantaneous; for when the electric current is applied to a body of ten tons of molten lead, and a couple of ounces of gold are dropped in at one edge of the kettle, a ladle of the lead instantly taken from any portion of the kettle shows traces of the gold, thereby indicating that the fusion of the gold and its infusion throughout the lead are instantaneous.

954. "Automatic or mechanical organs and harmoniums." J. G. SMITH. Dated March 4. 8d. Relates to a novel manner of providing a music-sheet for mechanical or automatic pianofortes, harmoniums, organs, and the like, and consists partly in the employment of metallic strokes, lines, marks, as shown in figure, or metallic dots upon the surfaces of paper, parchment, or other material, so that when a sheet or plate of any material is properly arranged in or upon a musical instrument, and caused to move over, under, or across the terminals of two of a series of wires, *t*, or



other suitable conductors connected with a battery or other generator of electricity, the circuit will be completed between the said points and through magnets arranged in connection with the valves, keys, or other parts, to cause the instrument to be sounded each time one of such metallic pieces comes in contact with the said ends of the wires or conductors. The length of the rows represents the length of the tune, and the number of rows will be in proportion to the degree of harmonisation or combination of tones of the chords. Various modifications are also included.

1046. "Compressing air by electricity for obtaining motive power." VICTOR POULET and E. COMMELIN. Dated March 10. 2d. The object of this invention is to obtain compressed air at a pressure of several atmospheres by means of electricity, with the same air acting upon pistons. An electro-magnet is employed, and an iron rod, which is attracted by the magnet, and serves as a piston, a lever being provided, which communicates with a fly-wheel and an air-pump, in connection with which is a pipe, through which the air is compressed into the boiler. An inlet pipe for air is fixed upon the boiler, and communicates with the slide and slide-rod of a secondary piston. A reservoir is

employed, in which air is compressed to several atmospheres, a safety valve being provided at the top, and connected with a whistle, the air passing to the safety valve through a small inlet cock at the side. A driving-wheel is provided at the back of the engine, and is connected by a rod with the second piston. A battery is used to give motion to a Gramme machine, which creates current in a second Gramme machine, which by means of a fly-wheel and connecting rod upon the main shaft of the said machine, communicates with the air-pump. (*Provisional only.*)

1049. "Magneto-electric breaks." C. GROOMBRIDGE. Dated March 10. 2d. Any suitable number of powerful electro-magnets is arranged in a bearing secured longitudinally between any two pairs of wheels to the longitudinal frame, or other suitable part of the carriage, the poles of such magnets resting lightly and longitudinally upon the face of the rails at all times and in such manner as to expose the entire surface of the poles of the magnet to the rails, which act as an armature or keeper to the magnet. Electric contact being made, and great friction being created, the motion of the vehicle will be at once retarded and arrested. (*Provisional only.*)

1081. "Telephonic apparatus." F. H. W. HIGGINS. Dated March 12. 2d. The transmitter consists of a diaphragm, to the centre of which is attached a spindle, which passes through a rod of carbon, the ends of which rest on two blocks of carbon, which are situated between the rod and the diaphragm. The rod is pressed inwards and outwards by two spiral springs on the spindle, which is provided with nuts so that the pressure of the springs can be adjusted. For receiver a Bell telephone is employed, constructed to sound loudly and clearly by the following means:—The energy of the vibration is increased by enormously increasing the magnetic stress upon the diaphragm; and in order that the latter may not produce extra tones it is made compound, either two or more iron plates being cemented together, or a piece of cardboard or other material stuck on the upper and under surface of the iron, except where it faces the magnet. As magnetism is sluggish in comparison with the rate of vibration required to reproduce vocal tones, the electro-magnetic coil is made of about one-eighth of an inch in thickness only, the diameter being of no consequence. An iron core is employed split to the centre. (*Provisional only.*)

1125. "Electric railway signals, &c." J. C. MEWBURN. (A communication from T. H. B. Putnam, of New York, U.S.A.) Dated March 16. 8d. An electrical conductor (Figs. 1 and 2) is arranged in a cavity on the road-bed,

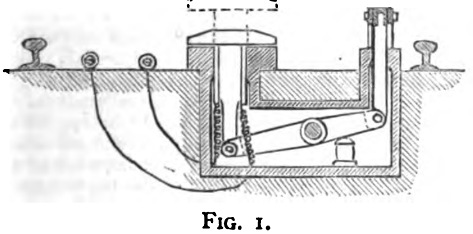


FIG. 1.

preferably midway between the tracks, and adapted to be elevated or protruded by the pressure of an extra wheel on the locomotive axle, acting through levers on the said conductor, as the train is passing. This conductor when protruded is swept by metallic brushes, or brush-like conductors, on the locomotive, by which means a circuit or circuits are closed. Wires lead from the protruded conductor to any point on the line,

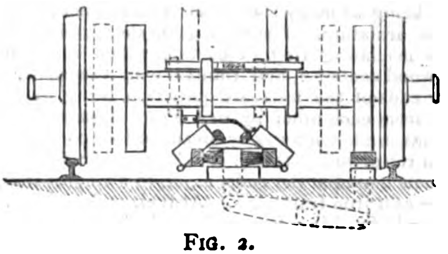


FIG. 2.

and are caused through suitable mechanism to make or break a circuit there also when required.

1136. "Magneto and dynamo-electric machines." J. H. JOHNSON. (A communication from A. de Méritens, of Paris.) Dated March 16. 4d. Consists in enabling these machines to furnish an alternate current without the employment of an exciting machine. The inductors are magnetised by the alternate current itself without the necessity for changing its direction by means of a commutator or collector. Taking the machine known as De Méritens as an example, all the coils of the ring are wound in such a manner that the exit wire from one coil is soldered to the exit wire of the next coil, and the extremity of the entering wire of one coil is soldered to the entering wire of the next coil. Hence it results that there are two entering or two exit wires leading to the binding screws where the current from the machine is collected. It also results that all the coils of the ring are traversed by one current, which changes its direction during each revolution as many times as there are coils in the ring. (*Provisional only.*)

1151. "Micro-telephonic apparatus." R. H. COURTENAY. Dated March 17. 2d. An iron or steel bobbin or core, with a soft iron on the base is, after being polished with a resisting medium, coiled with a number of lengths of wire insulated and connected by one end of each length to the bobbin. The bobbin is connected with a pendulum or spring of any suitable metals, either in the form of spiral or flat springs, coated with a resisting medium, the intention being to obtain delicate vibratory motion with the object of getting microphonic effects with less resistance as compared with carbon as generally used. (*Provisional only.*)

1178. "Dynamo-electric machine." JOHN PERRY. Dated March 18. 6d. The object of this invention is to get a very intense magnetic field, and at the same time to have the currents generated to be continuous. In the machines of Gramme, Siemens, &c., the winding of the wire bobbins takes place, as nearly as possible, in the plane containing the axis of rotation. In the new invention each winding of wire on the rotating part of the machine makes a decided angle with the axis of rotation. Fig. 1 is the sectional elevation of the machine; *e f* is a shaft made to rotate; *a b* is a ring of phosphor bronze on which a great number of thin wedge-shaped coils (*c*, fig. 2) are packed so as to form an annular armature whose section is shown at *k*, *k*, fig. 2. The plane of each winding of this armature makes an angle of 50 degrees with the direction of motion when turning with the shaft. The armature is firmly fixed to the shaft, and is kept from changing its shape during rotation by means of the wooden discs, *i*, *i*, which embrace the coils on the inner parts of the ring, and which are bolted together and fastened to the shaft by the screws and collar shown in the figure, and by means of the outer rings of wood and metal, *l l*, *l l*, which are bolted together, embracing the outside of the

ring. All the coils of the armature form one closed circuit, but the ends of one thin coil and of its neighbour are also fastened to an insulated rod of copper, *g h*, there being as many such rods as there are of thin coils on the armature. The ends, *g*, of these rods are fixed to an insulating ring of ebonite, which is fastened to the wood centre, *i*, and rotates with the shaft. The other ends of the rods are quite free, being only separated from each other by air. From these rods electric currents are taken away by means of four contact pieces, which rub or roll on them; $m\ m^1$, $m\ m^1$, are four electro-magnets bolted at the ends, *m*, *m*, to a ring of iron, and to the cast iron frame, *s s*. At their ends, m^1, m^1, they are firmly fixed in a frame of wood. The cores of these electro-magnets terminate in iron pole pieces of a sectorial shape, which are close to the armature; $n\ n^1$,

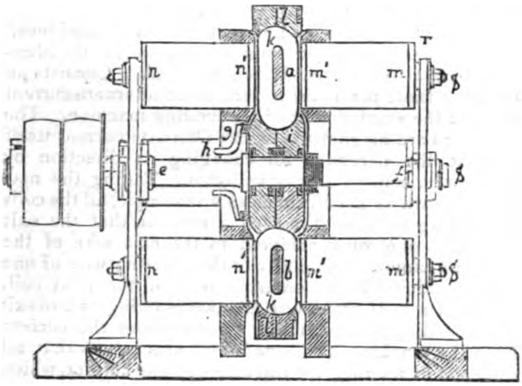


FIG. 1.

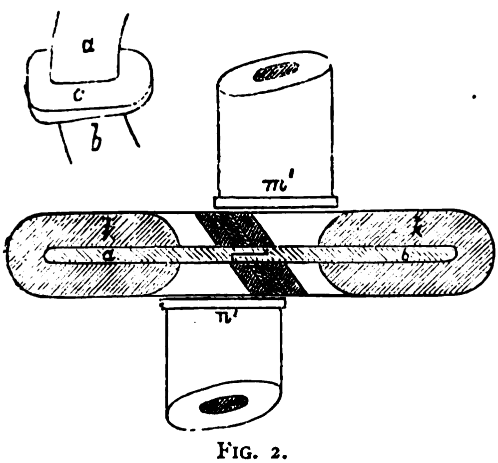
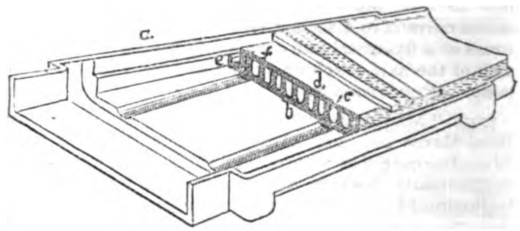


FIG. 2.

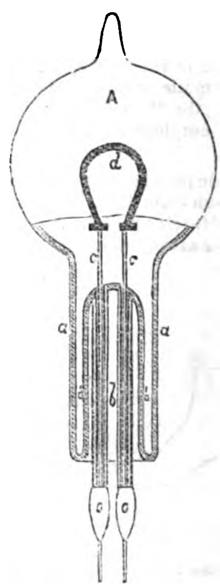
$n\ n^1$, are four similar electro-magnets, fixed in the same way on the other side of the armature in such a way that n^1 and m^1 do not come opposite to one another. In fact, the system of magnets $n\ n^1$ is rotated about ten degrees relatively to the system $m\ m^1$, and a line joining the middle points, *o o*, of two opposite pole plates makes an angle of about 50 degrees with the direction of motion of the ring at that place. The electrical connections are such that n^1 and m^1, fig. 2, have opposite polarity, so that between them there is formed an intense field of force, whose lines are nearly all at right angles to the planes of winding of the coils passing through it.

1184. "Telegraph wires." J. T. KING. (A communication from C. Linford, of Pittsburgh, Pa., U.S.A.) Dated March 19. 6d. Describes a cable consisting of insulated or cotton covered wires bunched together in any desired number, and held together by a strip of cotton or other cloth wrapped spirally around them.



The interstices are filled with melted paraffin, coal tar, or similar material, or the wires are immersed in melted paraffin, coal tar, or similar material, as or before they are bunched. The cloth wrapper is then coated externally with coal tar, asphaltum, rubber, cement, or other elastic impervious material. Then, if desired, another strip of cloth may be wound on it spirally in the opposite direction, and coated in like manner. The fig. shows a container having a box or bed, which may be of cast iron or other suitable material, preferably protected by tarring or otherwise coating its exterior. Its interior is fluted or grooved, as indicated at *b*, to form receptacles for the wire, and whole interior surface is coated with porcelain enamel, as at *c*. Upon the bed is a cover, *d*, adapted to fit within the flanges, *e*, and rest upon the shoulders, *f*.

2037. "Electric lamps." WILLIAM CLARK. 6d. (A communication from abroad by Patrick Drew, of Brooklyn, U.S.A.) Relates to improvements in electric lamps, by which the latter have their electrodes contained within a vacuum chamber of glass, the wires



being sealed where they pass through the glass by mercury or an amalgam inclosed around the wires.

The improvements are shown by the figure, which is

a sectional elevation of an electric lamp embodying the improvements.

A is the glass globe formed at one side with the tubular extension, *a*, and inner concentric cylinder, a^1, that is closed at the top, and formed with the sealing-tubes, *b*, *b*. The tubes, *b*, are formed with bulbs, *o*, for containing mercury to seal the wires, but the bulbs, *o*, may be dispensed with, the tubes being extended down and closed at their lower ends around the wire. The conducting-wires, *c*, pass freely through the tubes, so that the portion of the wires below the carbon, *d*, is free to expand and contract without danger of cracking the glass. The bulbs, *o*, shown in the figure contain mercury, which gives additional security against ingress of air.

2114. "Mechanism for perforating paper for telegraphic purposes." W. R. LAKE. 1s. (A communication from abroad by Theodore Marshall Foote, of Brooklyn, and Frank Anderson, of Peekskill, U.S.A.) Relates to a method of perforating paper slip for working automatic fast speed telegraphs, the perforations being arranged in such a way that whatever order the letters come in, the signals shall always consist of a series of positive and negative currents following one another alternately. The description of the apparatus for effecting the object will be referred to at a future date, as it cannot be described except at some length.

City Notes.

Old Broad Street, October 27th, 1880.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The fourteenth half-yearly meeting of the proprietors of this Company was held on October 22nd, at the City Terminus Hotel. The chairman, in moving the adoption of the report (see *Telegraphic Journal*, October 15th), said that he had little to add to the statements in that document. Their plant was in good order, and their cables were working well throughout. They were able to show a small but steady increase, the result of which had been that they were able to pay a bonus of 1 per cent. beyond the dividend of 5 per cent. They had also been able to add to the reserve, which fund was growing gradually to a considerable amount. The receipts from the cables showed, as compared with the half-year referred to at the previous meeting, an apparent increase of only £532. But that was not the real increase, because during the previous half-year the receipts were swollen by an unusual traffic to the Cape, occasioned by the Zulu war, to the extent of £3,700. If that were taken out of the receipts of the half-year which ended in December, the increase would really be found to be £4,232. A comparison of the two successive half-years was not a fair way of instituting a comparison with regard to traffic, as there were peculiarities which caused some half-years to be better than others. He would, therefore, compare the half-years ending in June, 1879 and 1880, from which it would be seen that there was an apparent increase in favour of the latter period of £2 953. But in the former half-year also the disturbing element of Cape traffic, which, owing to the establishment of the South African Cable, they did not get into, the receipts from the Cape traffic in the June half of 1879 amounted to £5,655. Apart from this, for the half-year ending June, 1880, when compared with the corresponding half of 1879, the increase was £8,607. The net percentage of profit on capital for the last half-year was £10 1s. 2d. per cent. and the net percentage on the whole year was £10 0s. 9d. Out of that they had paid the usual dividend of 5 per cent. and the bonus of 2s. per share, which brought the dividend up to 6 per cent. It was the general feeling of the directors that they should pay the proportion of the bonus as it was earned. So long as they made money enough to place a proper sum to the reserve they would pay the bonus in addition to the dividend. The total expenses for the half-year were £11,707, against in the previous half-year £11,494. The small increase was accounted for partly by special legal expenses, and partly by certain requirements at the stations. The general expenses in London showed a diminution of £17 in the half-year. On previous occasions he had never been able to congratulate the proprietors upon the position of their shares in the market, and he was now pleased to be able to state that for the first time they were selling at something over par. Sir Jas. Anderson seconded the motion. Mr. Spicer deprecated the action of the board in making so large a provision for the renewal of their cable instead of declaring a larger dividend, and suggested that the amount to be placed to reserve should in future be limited to £20,000 a year. Upon this question some discussion took place, after which the report was adopted, and the usual formal business having been transacted, the proceedings closed with a vote of thanks to the chairman.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The report of the directors, presented at the seventh ordinary general meeting, stated that the accounts for the six months ending June 30th, 1880, show the amount to credit of revenue is £36,358 16s. 7d., and the expenses have been £21,534 15s. 4d., leaving a balance of £14,824 1s. 3d., which with the balance of £1,017 11s. 6d. brought from last half-year's account, makes a total of £15,841 12s. 9d. Of this sum the directors have placed £10,000 to reserve account, leaving £5,841 12s. 9d. to be carried to the current half-year's account. During the interval between the disablement of the chartered maintenance ship *Caroline*, referred to in the last report, and the arrival in the West Indies of the s.s. *Grappler*, several cables were interrupted. Delay in the *Grappler's* operations, owing to unfavourable weather and further accidents to cables, caused an accumulation of breakages greater than one ship could overtake. The directors have therefore felt it essential to send out another ship to assist in the repairs. They have accordingly purchased the s.s. *Duchess of Marlborough*, which vessel, after being fitted as a telegraph ship, sailed from the Thames on the 14th inst., taking out 58 knots of new cable. For the purpose of this addition to the maintenance establishment, the directors have found it necessary to realise and appropriate the remainder of the investments in respect of the reserve fund. The directors acknowledge gratefully the consideration the Company has received from several of the subsidising colonies during the period of its exceptional difficulties. The shareholders must, however, be prepared for a further diminution of subsidy payments during the current half-year, as notice to that effect has been given to the Company. No official communication has been received from the Demerara Government in reply to the representations as to the non-payment of the subsidy referred to in the last report. The increased expense of the repairs in hand, caused by the very numerous interruptions, the additional cost of maintaining two ships in the West Indies, and the diminished traffic, consequent upon the interruptions, in the opinion of the directors, render it necessary to retain the balance on revenue account to meet contingencies, and obliges them to recommend that the payment for this half-year of the usual dividend on the preference shares be deferred. The present unsatisfactory condition of the system connecting so many important

dependencies of the Crown, arising as it does from the insufficiency of the subsidies, as supplements to an inadequate traffic, has been again brought before the Home Government and the colonies. The directors consider that it is incumbent upon them to negotiate for a revision of the colonial acts under which the telegraph was established, with the view of obtaining an increase in the amount of the subsidies and a modification of the onerous conditions under which they are payable. The action against the underwriters to the policy of insurance on the *Investigator* was part heard by the High Court of Appeal, in May last, and will be continued during the next sittings. The chairman (Mr. C. W. Earl) in moving the adoption of the report, said that although the accounts were disheartening, showing as they did no dividend for the preference shareholders, he did not think that those who were cognisant of the circumstances would be disappointed. On the last occasion he called attention to the broken down condition of their system. The general tenor of all their reports of late, since they had tested the earning power of their field, must have more or less prepared them for their present position. The cables had been down ten years, and ten years in their position seemed to be the life of a cable. It might seem to some shareholders that having made a profit they ought to declare a dividend on the preference; but since the turn of the half-year they had had several accidents to the cable, and traffic fell off accordingly. Under the circumstances it would have been unwise, or indeed impossible, to have paid anything. They had had to acquire a second ship to put their property into working condition, and this had not only absorbed the remainder of their investments, but necessitated a loan from their bankers. Sir James Anderson seconded the motion. Colonel Tinley thought there was not that heartiness in the management which there ought to be. The chairman, in reply to questions, said that the average payments to all their clerks at their stations was £100 a year. As to the life of a cable, he said that the line between San Juan and St. Thomas had been broken several times in the ten years. At the beginning of January they had seven sections interrupted, and now they had nine broken sections. The ground in the West Indies was particularly bad for cables. A discussion ensued. The motion for the adoption of the report was then put and negatived by a show of hands, upon which a poll was demanded, the result being the ultimate adoption of the report.

A new American Cable Company is announced in New York with a capital of three millions of dollars. The cable is to be laid from New York to Flores, the westernmost of the Azores, and thence to Land's End, Cornwall. From Land's End short cables will be laid to Brest, in France, and to a place not yet definitely fixed in Holland. It is said the cable is to be constructed by an improved method, and when made, will possess many important advantages over any other cable now in use. By means also of specially devised instruments it is *promised* that *one hundred words* per minute will be transmitted. According to the calculations of the promoters, the cable will yield a profit of 6 per cent. on the capital invested, even at the moderate charge of 2d. per word, or 20 per cent. at 4d. per word. A portion of the capital is said to be held in London and Paris as well as in New York. That such a company may be promoted we think is possible, but not that a dividend can be paid at 2d. per word.

The distribution on the Telegraph Construction and Maintenance Company's certificates, issued under the trust deed of March 12, 1875, will be made on and after November 1 next, at the rate of 3s. per £5 certificate.

The Direct United States Cable Company (Limited).—The board have resolved upon the payment of an interim dividend of five shillings per share, being at the rate of 5 per cent. per annum, for the quarter ended 30th September, 1880; such dividend to be payable on and after the 16th November next.

The Eastern Extension Telegraph Company (Limited).—The coupon due Nov. 1 on the £100,000 Five Per Cent. Debentures of 1880 will be payable on and after that date at the Consolidated Bank.

The following are the final quotations of telegraphs:—Anglo-American Limited, 63-63⅛; Ditto, Preferred, 93½-94½; Ditto, Deferred, 32¾-33¼; Black Sea, Limited, ——; Brazilian Submarine, Limited, 10-10¼; Cuba, Limited, 9-9½; Cuba, Limited, 10 per cent. Preference, 16¼-16¾; Direct Spanish, Limited, 2⅛-3; Direct Spanish, 10 per cent. Preference, 12-12⅛; Direct United States Cable, Limited, 1877, 12-12⅛; Scrip of Debentures, 102-104; Eastern, Limited, 9¾-10; Eastern 6 per cent. Preference, 12⅛-12⅜; Eastern, 6 per cent. Debentures, repayable October, 1883, 103-107; Eastern 5 per cent. Debentures, repayable August, 1887, 103-105; Eastern, 5 per cent., repayable Aug., 1899, 104-106; Eastern Extension, Australasian and China, Limited, 10-10¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 105-107; Ditto, registered, repayable 1900, 105-107; Ditto, 5 per cent. Debenture, 1890, 102-104; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 103-105; Ditto, ditto, to bearer, 103-105; German Union Telegraph and Trust, 9¾-10¼; Globe Telegraph and Trust, Limited, 6⅞-7⅛; Globe, 6 per cent. Preference, 12-12¼; Great Northern, 9⅞-10⅛; Indo-European, Limited, 24⅛-5⅛; London Platino-Brazilian, Limited, 4¾-5¼; Mediterranean Extension, Limited, 2⅛-3; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 11-11⅛; Submarine, 245-255; Submarine Scrip, 2⅜-2⅝; West Coast of America, Limited, 3⅛-3⅜; West India and Panama, Limited, 1¼-1½; Ditto, 6 per cent. First Preference, 6½-7; Ditto, ditto, Second Preference, 6-6½; Western and Brazilian, Limited, 8-8¼; Ditto, 6 per cent. Debentures "A," 105-107; Ditto, ditto, ditto, "B," 97-100; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 103-105; Telegraph Construction and Maintenance, Limited, 34¾-35¼; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 4-4¼; India Rubber Company, 17-17⅛; Ditto 6 per cent. Debenture, 105-107.

TRAFFIC RECEIPTS.

Name of Company.	September, 1880.	September, 1879.	Increase or Decrease.
	£	£	£
Anglo-American	*	...	...
Brazilian Submarine	a13,585	...	...
Cuba Submarine	1,800	3,314	Dec. 1,514
Direct Spanish	1,538	1,121	Inc. 417
Direct United States	*	...	...
Eastern	43,717	38,369	Inc. 5,348
Eastern Extension	28,771	26,980	Inc. 1,791
Great Northern	22,320	...	...
Indo-European	...	...	...
Submarine	*	...	...
West Coast America	...	...	...
Western and Brazilian	a11 064	a11,063	Inc. 1
West India	...	...	...

* Publication of receipts temporarily suspended.
a Five weeks.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 187.

FAST SPEED WORKING ON CABLES.

PERHAPS at the present time no field of invention offers to electricians so rich a prize as that of submarine telegraphy. It is well known that the duration of a cable in good working condition is comparatively brief. It follows, therefore, as a matter of necessity that the profit on the large capital outlay, entailed in laying a cable, and the requisite reserve fund, be secured during a short period varying from ten to possibly twenty years. Now the carrying power of a submarine line being limited (although, thanks to the ingenuity of Mr. Stearns and the Messrs. Muirhead, less so than formerly), it follows that while the above conditions last, the tariffs must remain quite up to the existing rates if they are to be at all profitable.

It is, however, a matter well worth consideration whether the carrying power of cables cannot be increased by the employment of a quadruplex or multiplex system, or by the employment of automatic fast speed apparatus. The latter seems the more likely field for successful invention, and although we believe something has been attempted in this direction, no success has been attained as yet. The idea of the new American Cable Company recently organised in New York, to submerge a translator or repeater in mid ocean, is undoubtedly a correct one, but the practical feasibility of the project is more than open to question. It is hardly too much to say that no piece of mechanism has ever yet been devised which can be trusted to work with certainty to an indefinite period without human supervision. As is well known, the cause of the retardation of signals in submarine cables is the inductive effect, which causes the cable to hold a charge which has to be got rid of after each signal has been sent and before another can be transmitted. Could some arrangement be devised by which this charge can be "wiped out" at *both* ends of the cable simultaneously, a great advance would be made towards solving the problem of fast speed submarine telegraphy. It seems to us that there is considerable scope for invention in this direction.

All inventions for working through long ocean cables must necessarily be unsatisfactory unless submitted to actual test; but the latter to the very great majority of inventors is an impossibility, as they cannot have access to any cable on which to make their experiments. Seeing the importance of the subject, we would suggest that amongst the apparatus provided for the proposed public electrical laboratory in connection with the Society of Telegraph Engineers, an artificial cable might with great advantage be included.

One thing is at least certain—that the fortunate inventor who can effect a notable improvement in the direction of fast speed submarine telegraphy will be in the enviable position of being able practically to demand his own terms. Take, for instance, the case of a company with a given number of cables, the traffic continuous, and the tariff adjusted so as to be sufficiently profitable. Continue the supposition, and imagine another company laying a single line of a precisely similar type of cable, but the carrying power of which was by any means considerably increased. The traffic over this cable could be conducted at a proportionately less rate than over any one of the others, with as good, perhaps a better, remuneration than it could be by the company owning the larger number of cables, but which worked at the slower speed.

The inventor who can materially increase the rate of working on submarine lines will be able, as we before stated, to demand his own reward; the then existing companies must either buy or run the risk of what would be an overwhelming competition. The field is open to all: a fortune will probably be the reward of him who tries to solve the problem, and—succeeds.

M. FLOYER, the Superintendent of the Egyptian Government Telegraphs, writes that he tried the Gower-Bell Loud-Speaking Telephone on the ordinary telegraph lines between Cairo and Alexandria, looping two lines together to get a total length of 260 miles, and that the talking was very successful, notwithstanding that Morse instruments were working on the adjoining ten lines.

IN connection with the subject of telephonic communication, we may mention that one of our largest railway companies, which twelve months ago considered the desirability of using telephones and then abandoned the idea, are now, after having tried the Gower improved instrument, anxious to have them applied generally on their system.

A NEW RELAY.

THE relay, a drawing of which is given below, is the invention of Mr. C. C. Vyle of the Postal Telegraph Department, London, and is really an adaptation of the principle used by Professor Hughes in the electro-magnet of his type-printer, though we believe the inventor was not aware of this fact for some time after his idea had taken practical shape.

In its appearance and build it is certainly not suggestive of the great delicacy which it undoubtedly possesses, as proved by exhaustive comparative trials with Post-office Standard Relays, and in actual working upon some of the longest and busiest circuits in the United Kingdom.

With slight alterations in the adjustments it is also claimed to work well as a direct double current sounder, and satisfactorily so in all weathers.

The general construction is as follows :—

An ordinary horse-shoe magnet, M, is laid horizontally beneath the base of the instrument, each leg of the magnet being fitted with a cylindrical soft iron continuation which rises perpendicularly through the base and goes to form the cores of the electro-magnet, C, C. The coils of the electro-magnet are wound differentially to 200 ohms each, and may therefore be worked singly or duplex. At one end of the lever, *l* (which works in jewelled bearings), and immediately over the cores, is fixed a soft iron armature, *a*, which is attracted by the induced magnetism of the cores.

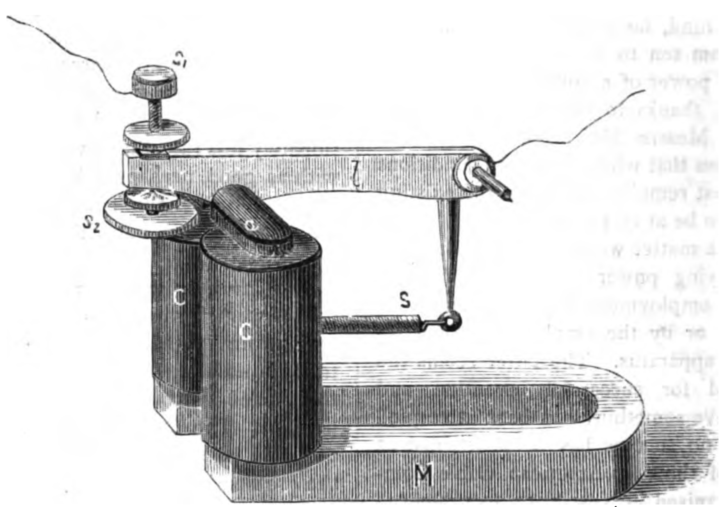
Towards the opposite end of the lever is attached a spiral spring, S, and adjusting screw, by means of which the force of the magnetised cores over the soft iron armature may be varied or counteracted as circumstances require. Still nearer this end of the lever are the limiting stops, S_1, S_2, insulated in the usual way.

The most delicate adjustment of the relay is said to be arrived at when the tension spring just balances the attraction of the cores and the lever lies indifferently in either position, and when the limiting stops are just sufficiently apart to break contact and prevent ill effects from the spark from the local battery.

For sounding purposes, the stops of course require opening out considerably.

From the foregoing it will readily be understood that if a current be sent through the coils tending to strengthen the polarity already induced in the cores by the permanent magnet, the soft iron armature will be drawn to or retained upon the cores against the tension of the spring ; if, however, the current should be in such a direction as to tend to neutralise the existing polarity, then the attractive power will be lessened and the spring will do its work by drawing up the lever to the top stop.

The relay, when well made and well adjusted, will give good signals with one Daniell cell working through a resistance of 10,000 ohms, and if the latter be all removed the relay will still respond properly without requiring to be re-adjusted ; this is a great point.



Although Mr. Vyle may not have discovered any new principle in his relay, yet he has certainly shown that there are still some old ones to be worked out.

NEW ELECTRIC LAMPS.

SWAN'S INCANDESCENT LAMP.

AT a recent meeting of the Literary and Philosophical Society of Newcastle-on-Tyne, Mr. J. W. Swan brought forward and exhibited his new incandescent electric lamp, which is undoubtedly the most perfect of the kind yet devised. The original form of the lamp devised twenty years ago by Mr. Swan is shown by fig. 1, which represents the front elevation of the lamp. For various reasons this lamp did not prove a success, the principal cause of failure being that which has been observed in other lamps of the kind, viz., the con-

tinual volatilisation of the carbon, which caused a smoky deposit to be deposited on the sides of the glass globe in which the incandescent carbon was set. This volatilisation, Mr. Swan has discovered, may, to a great extent, be prevented by making the vacuum in the glass a very perfect one, the carbon being heated to a high degree of incandescence whilst the exhaustion is progressing. A special method of preparing the carbon has also been discovered by Mr. Swan, so that the material can be formed into very thin strips as hard and elastic as a bit of steel, and unalterable by the action of the current as far as has been seen at present.

The new form of lamp is shown by fig. 2, and is self-explanatory.

As regards economy, Mr. Swan stated that more illuminating power was indirectly obtained from gas burnt in the engine than was obtained from the much larger quantity of gas consumed at the burners.

SCRIBNER'S ARC LAMP.

This lamp is the invention of Mr. C. E. Scribner of Chicago, and in general principle is similar to the "Brush" lamp, though it differs from the latter in several particulars.

Fig. 3 is a front view, and fig. 4 is a side view of the lamp.

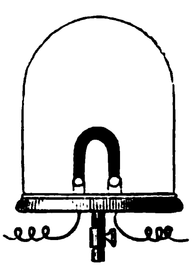


FIG. 1.

C is an electro-magnet of small resistance placed in the circuit of the carbon points, E, E[1], and of the generator of electricity.

The poles of the magnet, C, C, are faced with copper or other non-magnetic metal, so that the iron armature, N, cannot come into contact with them; *h*, *h*, are two brass screws fixed into the poles of the electro-magnet, and passing through holes in the armature. E, E[1], are the carbons; they are held in the metal supports *p*, *p*[1]; W, V, and T, are binding screws to receive the connecting wires.

There is a hole in the armature, N, through which a rod, F, passes, and the hole fits the rod so closely that when the armature is slightly inclined the rod becomes nipped in the hole, but otherwise the hole is just large enough for the rod to move freely through it.

To the armature, N, two springs, M, are attached, one on each side of the rod, F. These springs are sufficiently strong to sustain the rod, F, in the position it occupies against the force of gravity acting on the rod, its carbon, and carbon carrier; K, L, are two springs of unequal tension acting on the armature, N. *l*, *m*, are regulating screws screwed into the frame as shown, and serving to regulate the tension of the springs, K, L.

D is an electro-magnet of high resistance placed in a shunt circuit shunting the voltaic arc; its poles are tipped with brass or other non-metallic metal to prevent the armature coming into actual contact with the poles of the magnet; *g*, *g* (fig. 3), are two brass screws screwed into the poles of the electro-magnet, D, and passing freely through holes in the armature, H. There is also another hole in the armature, H, through which the rod, F, passes.

The rod, F, fits the hole in the armature, H, so nearly, that when the armature assumes a slightly inclined position in relation to the rod, it locks itself fast upon the rod; nevertheless the hole is sufficiently large to allow the armature to move independently of the rod when it is at right angles to it; I, J (fig. 3), are two springs of unequal tension acting on the armature, H; *f*, *f*, are two regulating screws screwed into the frame, and serving to regulate the tension of the springs, I, J; *a* is a tongue (fig. 4) projecting from the armature, H; G is a metal support.

O is a piece of vulcanite or other non-conducting matter attached to the support, G, by the screw, *o*;

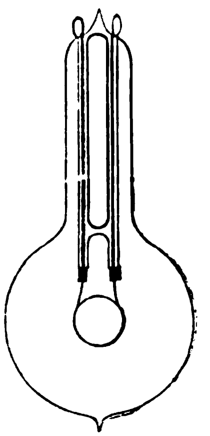


FIG. 2.

p is a piece of metal mounted in a guide-groove on G, in such manner that it can move vertically; *i* is a screw passing through the spring, *r*, and also through a slot in *p*; it is screwed into the support, G. The spring, *r*, is held by the head of the screw, *i*, so as to press against *p* with a force sufficient to maintain it in place against the action of gravity; *b*, *b*[1], are screw-stops tipped with vulcanite or otherwise prevented from forming an electrical connection with the armature, H. They are screwed into the piece, *p*; *d* is a flat spring, and *e* is a rigid stop for the spring, *d*; *c* is a platinum-pointed screw screwed into a small boss upon the end of the spring, *d*.

The main current enters by the binding screw, W, the voltaic arc, the rod, F, and by a flexible wire to the binding screw, V, from thence by the coils of the electro-magnet, C, C, to the binding screw, and by a return wire to the generator.

The current in the shunt circuit shunting the voltaic arc passes from the binding screw, W, by the wire of the electro-magnet, D, the screw, *o*, the

frame, *g*, the piece of metal, *p*, the screw, *c*, the spring, *d*, and the wire connection to the binding screw, T.

When there is no current passing through the lamp or regulator, the armature, H, sustained by the springs, I, J, rests against the heads of the screws, *g*, *g* (fig. 3), and the tongue, *a*, pressing on the point of the screw, b^1 (fig. 4), holds the piece, *p*, in contact with the point of the screw, *c*, and the shunt circuit is thus closed. The armature, N, is also drawn away from the poles of the electro-magnet it takes a position square with the rod, F, and ceases to nip or lock itself with the rod, which is then maintained in position against the force of gravity acting upon it by the friction holding of the springs, M, M.

The electric current divides itself between the main circuit and the shunt circuit, and the relative quantity of current in the two circuits is inversely proportional to their resistance.

As the points of carbon burn away and become more distant the one from the other, the resistance

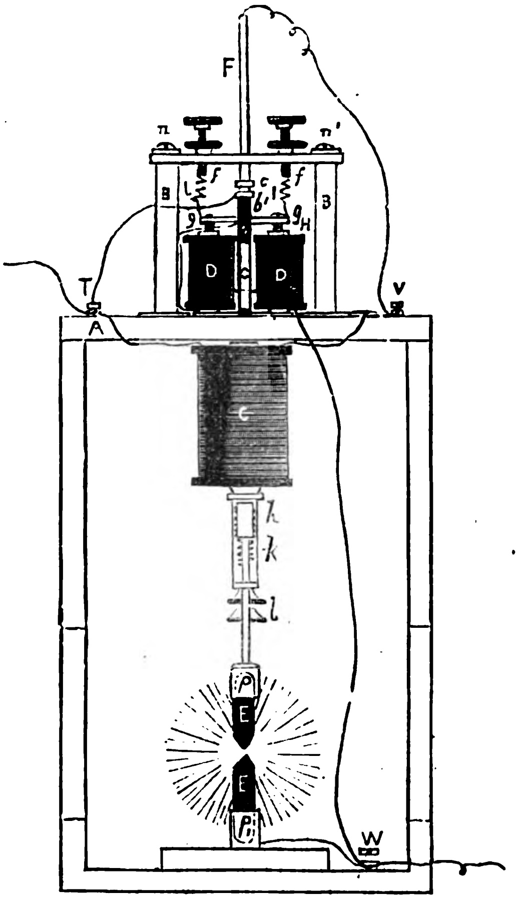


FIG. 3.

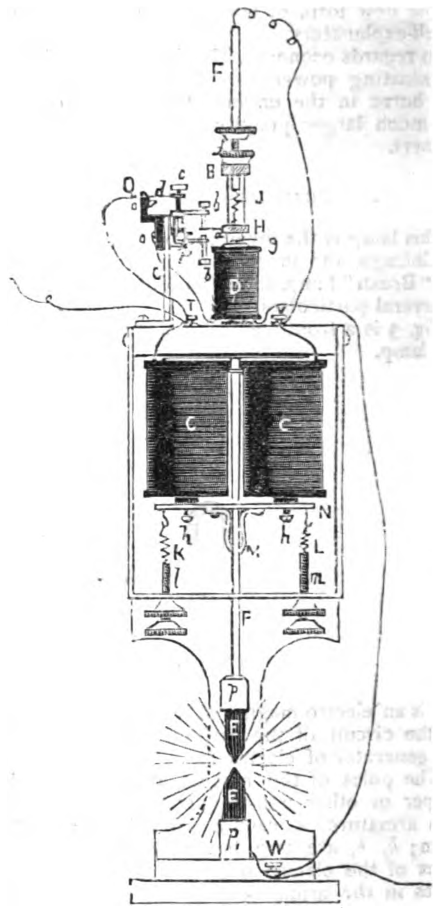


FIG. 4.

magnet, C, by the springs, K, L, until the points of the carbons, E, E^1, come into contact.

As soon as the current from the generator passes through the regulator the armature, N, is drawn towards the poles of the electro-magnet, C, C, and in consequence of the unequal tension of the springs, K, L (fig. 4), the armature, N, in approaching the poles of the electro-magnet, assumes a position inclined to the rod, F, and nipping or locking fast with it, carries the rod up, and thus the carbon points are separated and the voltaic arc established.

When the armature, N, comes against the poles of the voltaic arc gradually increases, and consequently the quantity of electricity passing in the coils of the electro-magnet, D, also gradually increases, and the attraction of the magnet upon the armature, H, becomes stronger.

When the attraction is sufficient to overcome the tension of the springs, I, J, the armature, H, approaches the poles of the electro-magnet, D. In consequence of the unequal tension of the springs, I, J, the armature, H, when attracted towards the poles of the electro-magnet, D, takes a position inclined to the rod, F, locks itself to the rod, and

as the armature itself descends carries it down in spite of the friction holding of the springs, M, and so the carbon points, E, E[1], are brought nearer together.

When the armature, H, is drawn down as described above, the tongue, *a*, comes to the point of the spring, *b*, and pressing upon it causes the piece, *p*, to move, so as to separate *p* from contact with the point of the screw, *c*. By this means the shunt circuit is broken and the electro-magnet, D, loses its magnetism. The springs, I, J, immediately bring back the armature, H, to a position square with the rod, F. The armature then ceases to nip the rod, which remains in the position to which it was brought during the descent of the armature, being supported in the frictional holding of the springs, M. The armature, H, is then brought back by the springs, I, J, to its first position against the heads of the screws, *g*, *g*. By the same movement the tongue, *a*, is brought up to the screw, *b*, and pressing on its point it raises the piece, *p*, into contact with the point of the screw, *c*, and the shunt circuit is again complete.

The current passing in the shunt circuit has, however, been decreased by the approximation of the carbons brought about during the descent of the armature, H, and so the armature will remain for a certain time against the heads of the screws, *g*, *g*, until by the further consumption of the carbons the resistance of the main circuit again becomes sufficient to divert a sufficient proportion of the current through the shunt circuit to enable the electro-magnet, D, again to draw down its armature.

The length of the voltaic arc can be regulated by varying the tension of the springs, I, J. The length of movement of the armature, H, and consequently the distance of the rod, F, carried down at each movement of the armature, can be regulated by adjusting the screws, *b*, *b*[1].

SPAGNOLETTI'S ELECTRICAL FIRE ALARM.

THIS invention consists, in the first place, of a train of clock-work to run off a paper ribbon as in a Morse telegraph instrument. This train of clock-work is automatically started into action by the same current that sends the signal from the place the alarm is given; it can also be made to stop automatically, or it can be stopped by the attendant after seeing what station has given an alarm. The instrument has an indicator on it, and shows when it requires winding up. A bell is also attached which is made to ring when winding up is required, so that if this is neglected notice is given of the fact. In addition to this a key for sending a current to any outlying station is attached for acknowledging signal or signals. Bells are added to call attention when an alarm is given; these bells may be tremblers, but each has attached to it an earth connection for the bell hammer to work against, so as to discharge the line wire. By this contrivance any number of bells can be arranged on one wire; without this arrangement this cannot be done. The signal given denoting a station sending an alarm is given by a code of letters or ciphers. These signals are sent in the following way:—

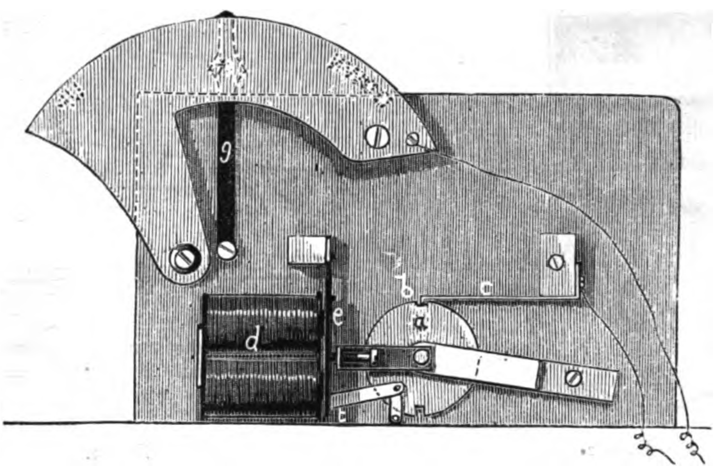


FIG. 1.

Graduating slopes or planes are fixed in a box and are covered or partly covered with metal or wire, so arranged that a metal ball, ring, or wheel will gradually roll down these slightly inclined planes or slopes, and in order to arrest its speed even stages are provided here and there. As the ball, ring, or wheel follows its course and runs over the metal lines it joins one to the other through itself, and thus completes the circuit. The metal being at required intervals insulated (or terminated in certain sections) the ball ceases to make contact when passing over these portions, and thus any signals required can be sent. The ball following

its course can be made to repeat any number of signals or a signal any number of times, or the ball can be made to press down light springs as it travels, the springs making contact as required. On the ball terminating its course it rests on pieces of metal, and connects if required a bell for the acknowledgment signal from the station the signal has been sent to, so that the simple act of dropping this small metal ball into the box starts the instrument at the station, records the letter or cipher of the station sending the signal any number of times required, rings a bell to call attention at the far end signalled to, and finally connects up a bell for the return or acknowledgment signal. One line wire is all that is required, but with two a system can be arranged by which all outlying stations can be

This wheel, *a*, is actuated by the ordinary clock-work, and during its revolution the contact of the wheel, *a*, between the slots is maintained with spring, *c*, and the instrument is kept working. *d* are coils which set the instrument in motion by pulling forward the piece, *t*, when armature, *e*, is attracted; *f* is a quadrant, which, with pointer, *g*, shows when the instrument requires winding.

Fig. 2 shows the bell for calling attention when alarm is given. To this bell is applied the spring, *a*, which has an earth connection, so that as the bell is struck the part, *b*, comes against *a*, and the line wire at each stroke is discharged.

Fig. 3 shows the box with graduated slopes or planes; *c* is ball, which on spring, *d*, being raised, rolls down the slopes, space being allowed for the

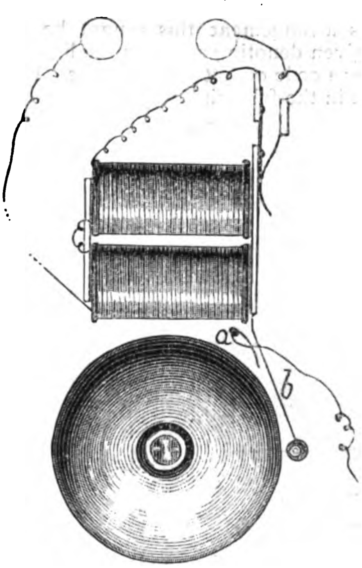


FIG. 2.

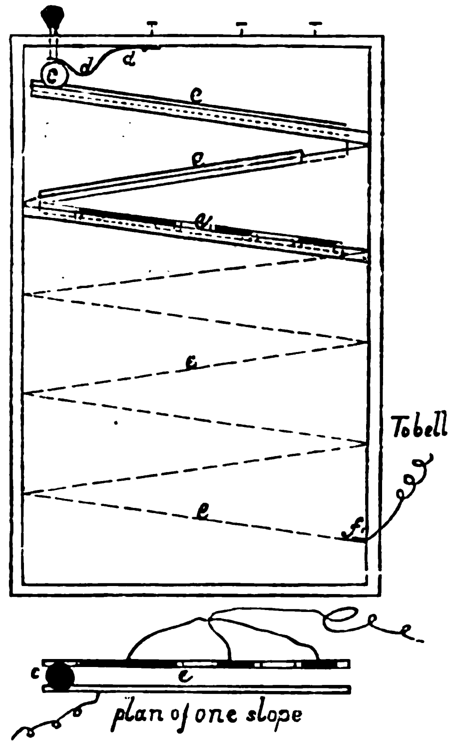


FIG. 3.

signalled to giving notice where a fire is, so that if any station signals to the head office of the district that a fire has broken out, the head office can send to all outlying stations and advise them where the fire is. This is done by audible or other signals. One instrument is sufficient for any number of outlying stations, but by having less stations on one, and using two or more, it may be found more convenient. One battery is required for the instrument, and one may be used for the bells. When the system of sending between all stations is adopted this can be arranged by multiplying the apparatus.

Fig. 1 represents the arrangements adapted to an ordinary Morse instrument; *a* is a wheel on which are formed slots, *b*, into which spring, *c*, takes.

ball to fall from one slope to another. In its course by running over the metal lines, *e*, the necessary indications are given. On arriving at f^1, a bell is connected up to receive an acknowledgment signal.

MAXIM'S ELECTRIC-LIGHT CURRENT REGULATOR.

THE current regulator, which is shown in perspective in fig. 1 and side view in fig. 2, controls the current perfectly, and proportionates it so accurately to the work to be done that it makes no difference whether there are 50 lamps in the circuit or only one, the current in the single lamp when

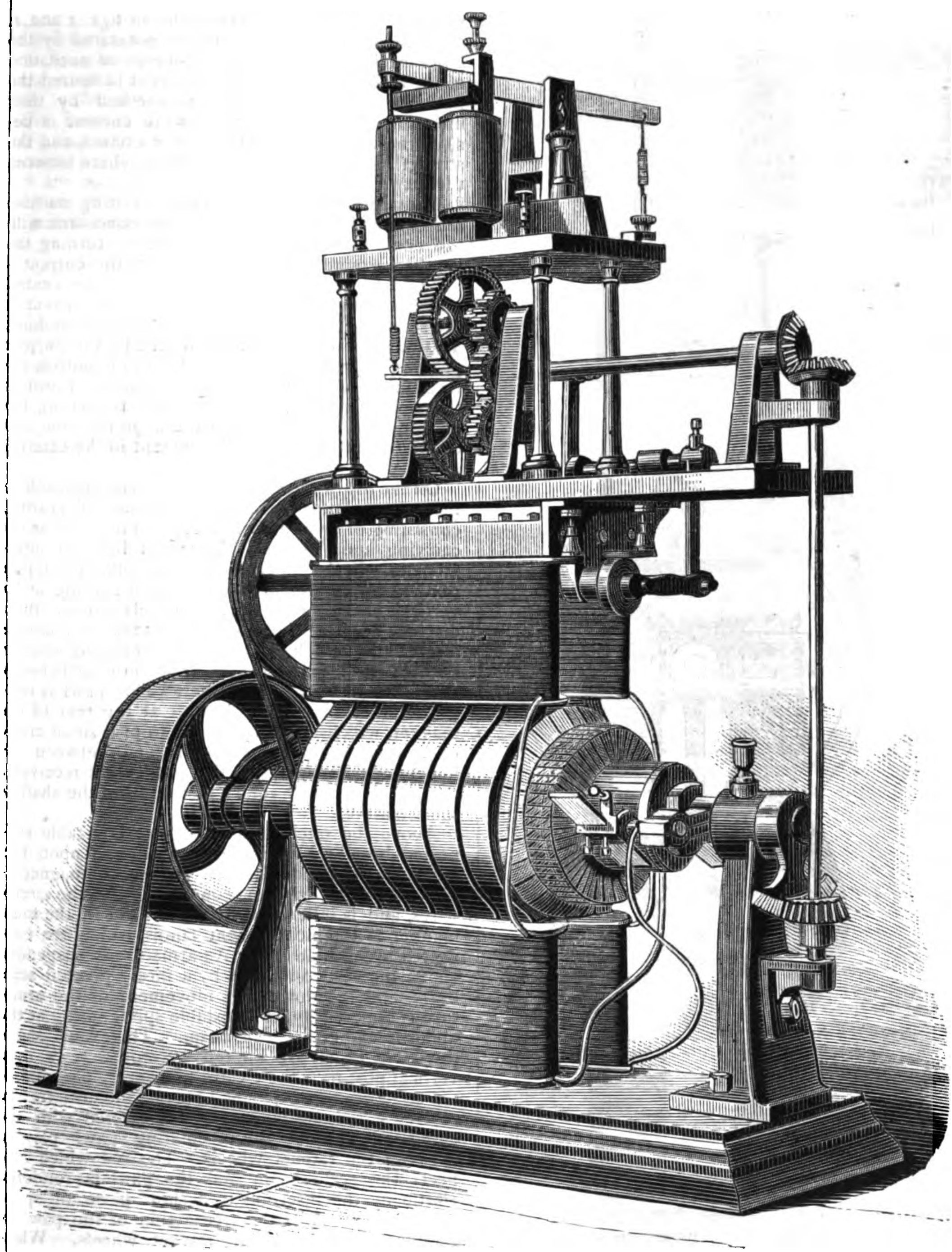


FIG. 1.

used alone, being the same as it is when the lamp is associated with 49 others in the same circuit.

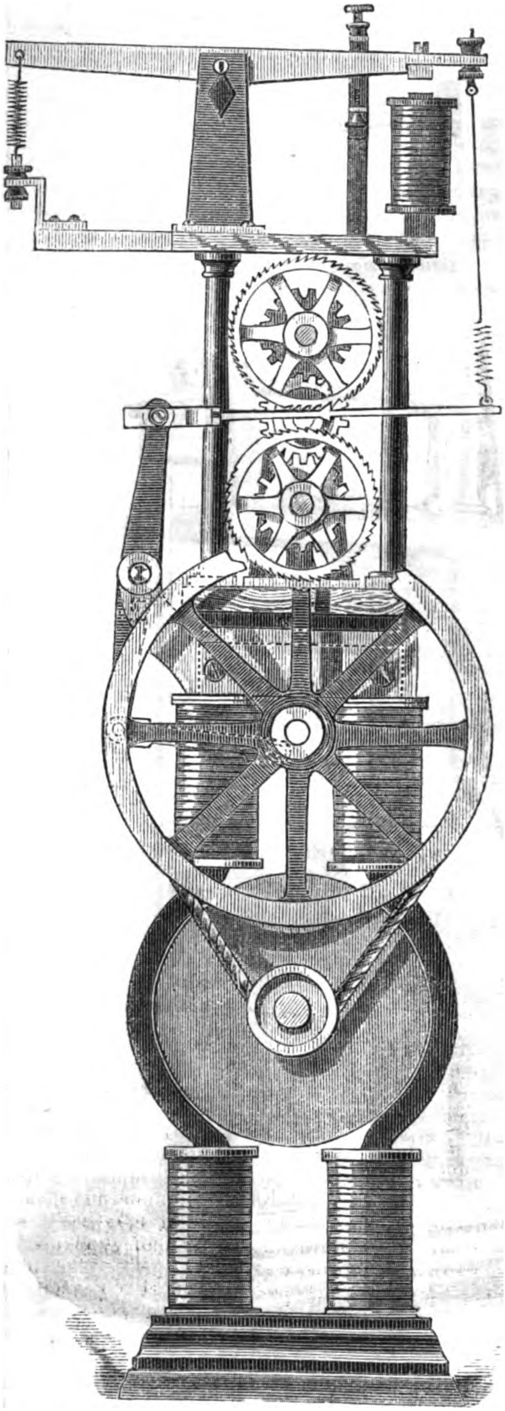


FIG. 2.

The manner in which this result is secured will be apparent on studying figs. 1 and 2. Where a number of large machines are used, the field magnet of each machine will be excited by a small dynamo machine like that shown in connection with the current regulator in figs. 1 and 2, and the strength of the current generated by the large machine depends on the degree of excitation of its magnets. If a strong current is desired the field magnets are strongly magnetised by their inclosing helices. If a very weak current is desired the magnets are but slightly excited, and the strength of the current may vary anywhere between these two extremes.

The commutator brushes of the exciting machine are arranged to swing on a bearing concentric with the commutator cylinder, so that by turning the brushes around to the neutral points the current is nil, and by turning it back nearly to the central position between the neutral points the current is the strongest that can be obtained from the machine. The current regulator is influenced by the current proceeding from the large machine and controls the mechanism which moves the commutator brush of the small machine, in this manner regulating the excitation of the magnets of the large machine, and consequently controlling the current in the external circuit.

On the top of the magnets of the exciting machine there is a platform supporting a train of gearing, consisting of two ratchet wheels mounted on shafts carrying spur wheels which mesh into an intermediate wheel connected with the pivotal support of the commutator brushes by bevel gearing and a vertical shaft. The ratchet wheels are a short distance apart, and between them there is a double faced pawl, which is capable of engaging one or both of the ratchet wheels, or of moving between them without touching either. This pawl is reciprocated by an oscillating shaft at the rear of the magnet, which takes its motion from a small crank on a shaft above the armature and between the helices of the magnets. The crank shaft receives a comparatively slow rotary motion from the shaft of the armature.

Above the ratchet gearing there is a table supported by pillars from the platform, and upon this table near one side there is an electro-magnet of high resistance, which is connected with the circuit wires, and is influenced by the current in the same manner as the incandescent lamps, which are connected in multiple arc. An armature is suspended above the electro-magnet by a nicely pivoted scale beam, and the downward movement of the armature is opposed by an adjustable spiral spring at the opposite end of the scale beam. The excursions of the scale beam are limited by stop screws in a vertical post near the electro-magnet. The end of the scale beam is prolonged beyond the armature to receive a rod, by which it is connected with the elongated end of the oscillating pawl playing between the ratchet wheels. The rod which connects the scale beam and the pawl is rendered elastic by the insertion of a short piece of spiral spring, to admit of the free action of the pawl in catching the teeth of the ratchet wheels. When the strength of the current is augmented by the removal of several lamps from the circuit, the armature of the regulator magnet is drawn down, permitting the pawl to engage with the lower ratchet wheel, which is turned one notch at a time

until the commutator brushes are moved, so as to reduce the exciting current, and consequently diminish the current in the lamp circuit. Should the current diminish beyond the normal strength the armature is released, the spring moves the scale beam, bringing the pawl into engagement with the upper ratchet wheel, when the result will be opposite to that just described.

The incandescent lamps, in connection with which this regulator is more especially intended to be used, are connected in multiple arc; that is, they are connected across two parallel wires, so that the current is divided up between all of the lamps in the same circuit. Now, it is obvious that, when a number of the lamps are removed, the current would, under ordinary circumstances, be much stronger in the lamps that are allowed to remain in the circuit, but when the regulator is applied there is no perceptible difference in the light given out by the lamps, whatever may be the number in circuit.

As many as 64 lamps have been brought up to over 30 candle-power each in a single circuit by one large machine, and the lamps have been removed from the circuit until only one remained and then all replaced, the regulator meanwhile adapting the current perfectly to the widely varying conditions.—*Scientific American.*

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XXI.

THE UNIVERSAL BATTERY SYSTEM.

WITHIN the last two years the system of working several circuits from one set of batteries has been revived with great success. This system, which was tried many years ago, appears to have failed on account of the unsuitableness of the batteries employed for the purpose, and also, no doubt, on account of the imperfect state of the insulation of the lines at that period, which rendered heavy battery power necessary for working a single line when the weather was bad and leakage considerable. At the present time, when the lines are kept in a high state of efficiency, the Universal system is entirely successful and economical.

The possibility of the Universal system is dependent upon the fact that when a battery has a low resistance the connection to it of several lines of equal resistance reduces the *total* resistance in the circuit of the battery nearly in direct proportion to the number of lines connected up, and as this reduction of resistance increases the amount of current flowing out of the battery proportionately, the total amount of current when split up amongst each of the lines gives to each a current of nearly the same strength as that which would be obtained on a single line connected to the same battery. If we suppose the current from the battery with one line connected to it to be 1, then 1 will be the current working the line. If now we connect two lines to the battery the resistance in the circuit of the latter becomes halved, consequently the current flowing out will be 2, and half of this will flow through each line—that is to say, there will be a current equal to 1 flowing through each. Similarly, if we have three lines, the current out of the battery will be trebled, and a third of this, or a current equal to 1, will flow through each line, as at first.

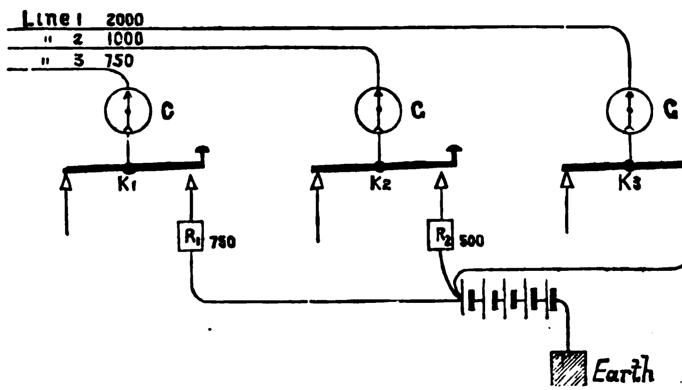


FIG. 79.

If the resistance of the battery were equal to 0, then no matter how many lines of equal resistance we added on, the current through each would still remain the same. But it is, of course, impossible to get a battery of a resistance equal to 0; as long, however, as the joint resistance of all the lines is not *less* than the resistance of the battery, the current flowing through each line will not be very much less than that which would flow through a single line, supposing the latter were the only one connected to the battery. In fact, so long as the joint resistance of all the lines worked from the battery is not less than the resistance of the battery, then no matter how many lines we connect to the

latter, the current through each of them can never be less than one-half the current which would be obtained through any single line of the set, supposing that line were the only one connected to the battery, and as a rule it would be very much more than one-half. Thus, for example, suppose we grouped two lines, each having a resistance of 200 ohms, on to a 10-cell Daniell battery of 100 ohms resistance, then if one line were connected to the battery the current flowing through the line would be

$$\frac{10}{100 + 200} \times 1{,}000 = 33 \text{ milliwebers},$$

and if the two lines were connected then the current out of the battery would be

$$\frac{10}{100 + \frac{200}{2}} \times 1{,}000 = 50 \text{ milliwebers},$$

and of this $\frac{50}{2}$ or 25 milliwebers would flow through each line. So that with one wire of 200 ohms resistance connected we have 33 milliwebers flowing through that wire, and with two wires we have 25 milliwebers flowing through each wire—that is to say, the current on any one wire might vary from 33 to 25 milliwebers.

If we had three lines of 300 ohms each, then with a single line the current would be

$$\frac{10}{100 + 300} \times 1{,}000 = 25 \text{ milliwebers},$$

and with the three lines all connected the current from the battery would be

$$\frac{10}{100 + \frac{300}{3}} \times 1{,}000 = 50 \text{ milliwebers},$$

and of this $\frac{50}{3}$ or 16·7 milliwebers would flow through each line. So that with one wire of 300 ohms resistance connected, we have 25 milliwebers flowing through that wire, and with three wires we have 16·7 milliwebers flowing through each—that is to say, the current on any one wire might vary from 25 to 16·7 milliwebers.

To take an extreme case, suppose we had 100 wires of 10,000 ohms resistance each, and one of these was connected to the battery, then the current through that wire would be

$$\frac{10}{100 + 10{,}000} \times 1{,}000 = 1 \text{ milliweber},$$

and with all the wires connected we should have a current out of the battery equal to

$$\frac{10}{100 + \frac{10000}{100}} \times 1{,}000 = 50 \text{ milliwebers},$$

and of this $\frac{50}{100}$ or $\frac{1}{2}$ milliweber would flow through each wire—that is to say, on any one wire the current might vary from 1 to $\frac{1}{2}$ a milliweber.

In each of the cases we have taken the joint resistance of all the wires is equal to the resistance of the battery. In the last case we have seen that if all the circuits were working at once the current which would be produced on each would be half that which would be produced on a single wire working by itself. It is, however, highly improbable that every circuit would be transmitting a signal exactly at the same time, consequently the likely variation in the current would in practice be very much less than that indicated.

As a rule it is seldom that more than five or six circuits can be grouped together on one battery, as the combined resistance of a greater number of circuits would, as a rule, be less than the resistance of the number of cells which would be required to work them.

It is not absolutely necessary that the circuits worked from one battery be all of exactly the same resistance, though it is not considered advisable to let the variation be greater than 25 per cent.—that is to say, the lowest resistance of any circuit in a group must not be less than the resistance of the highest in the group, minus 25 per cent. For example: if the highest resistance in a group were 2,000 ohms, then no circuit in the group must have a less resistance than 1,500 ohms, for 2,000 minus 25 per cent. equals 1,500.

When it is found impossible to select a number of circuits to form a group without infringing the foregoing rule, then certain of the circuits will require to be brought or levelled up to the required standard by the introduction of artificial resistances in the *battery leads* of the short lengths. In estimating the values of these resistances 25 per cent. less than the resistance of the longest line is taken as the standard. Thus, if we had five circuits of the respective resistances, 2,000, 1,500, 1,000, 800, 600, then resistance-coils would be added in the battery leads of the three latter circuits of the respective resistances, 500, 700, and 900, for

$$1{,}000 + 500 = 1{,}500.$$
$$800 + 700 = 1{,}500.$$
$$600 + 900 = 1{,}500.$$

It is not considered advisable to balance all the circuits up to a level with the highest standard, since the longer circuits are more affected by leakage than the shorter ones, and their resistances consequently decrease more in wet weather.

The Universal battery consists of either "UK," or "Bichromate" cells. The number of UK cells employed for single current circuits being equal to the number of "Daniell" cells (whether UK, chamber, or ordinary) formerly required to work the circuit of the highest resistance in the group. For *terminal* instruments worked with double currents, as, for instance, the single needle or the double current Morse, *double* the number of cells referred to are required, for, as will be seen, each current has to be sent from an independent battery. If the instruments are intermediate, a greater number of cells may be required, as will be seen hereafter.

If bichromate batteries are used, the number of cells required is only half that of the Daniell cells, as the Bichromate has double the electro-motive force of the Daniell battery.

It was pointed out that the joint resistance of all the lines (after they are levelled up by resistances) grouped on a Universal battery must not be less than the resistance of the battery, hence when a number of circuits are converted to a universal battery system, the following simple rule will determine what kind of battery is best (either bichromate or Daniell) for working the group :—

Divide the resistance of the circuit which has the greatest resistance in the group by the number of circuits, then the resistance of the battery to work the group must always be less than the result of

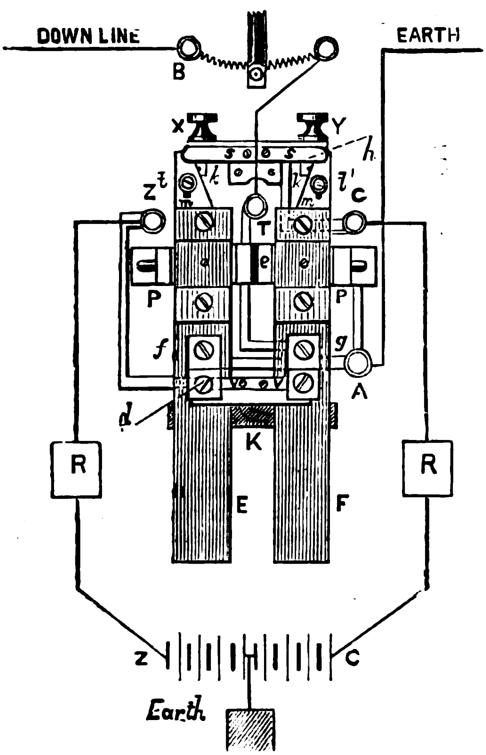


FIG. 80.

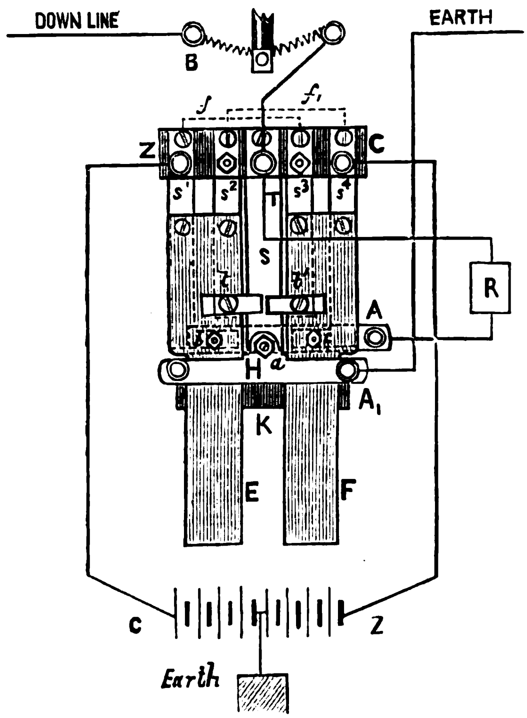


FIG. 82.

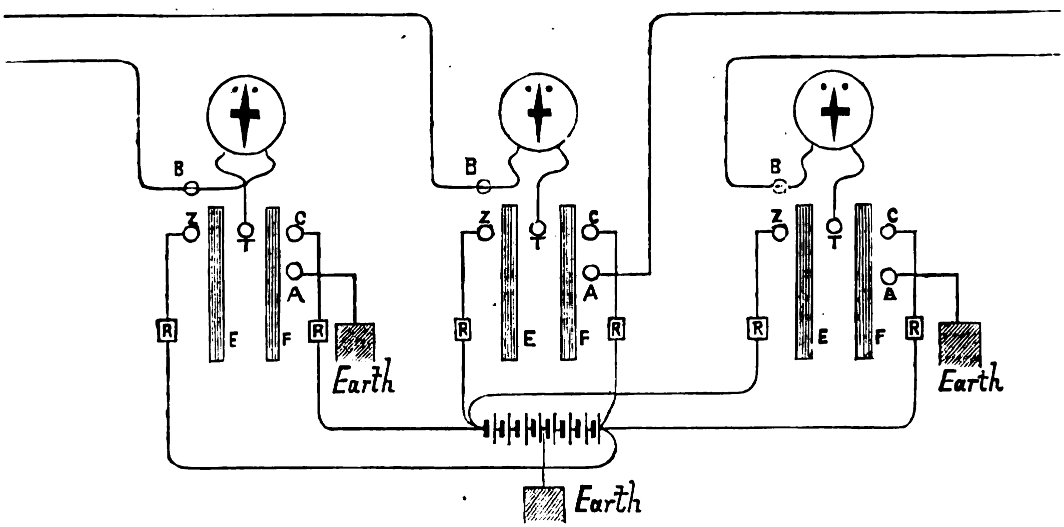


FIG. 81.

such division. Thus, if there are five circuits, the highest of which has a resistance of 1,400 ohms, the resistance of the battery employed should be less than 280 ohms, which result is arrived at by dividing 1,400 by five. If, then, 50 Ordinary Daniell cells sufficed for the circuit of highest resistance before it was grouped on a universal battery that number of UK cells will suffice for the group, because the resistance of 50 UK cells averages 5 ohms per cell, or 250 ohms in all, and this is less than 280. On the other hand, if 70 Ordinary Daniell cells were required, then, since the total resistance of 70 UK cells is 350 ohms, it will be necessary to adopt bichromate cells, as the resistance of these cells is only about one-half that of UK cells, whilst, as already stated, their electro-motive force is twice as great. If with five circuits the resistance of the batteries, even when bichromate cells are used, is greater than a fifth of the resistance of the circuit of highest resistance, a smaller number of circuits must be grouped together.

Direct Writer Circuits.

These circuits are the simplest to work from a Universal battery, and the general principle of the arrangement is shown by fig. 79. K_1, K_2, K_3, are three ordinary single current keys, with their front stops connected to the copper of the Universal battery, two having levelling resistances, R_1, R_2, in the circuit of the leads. The back stops of the keys are connected to earth through the receiving instruments in the ordinary manner. In direct writer instruments the usual connection on to the z terminal is removed, and the zinc pole of the battery is instead earthed in the battery room.

As a rule "Up" and "Down" instruments are not grouped together, but each kind are formed into a separate group, and worked from a separate universal battery. This is done in order to meet the case where a relay may be inserted in a direct writer circuit, for then the changing of an Up instrument into a Down, or *vice versâ*, would involve the connections of the relay being changed, which might cause confusion.

The connections for direct writers grouped on a universal battery at an "Up" station are similar to those for ordinary working, except, as has been pointed out, the z terminal is left disconnected, and the zinc pole of the battery is put to earth in the battery room, or at the test box. At a "Down" station the line and earth connections are reversed, that is to say, they are the same as at an "Up" station, and the zinc of the universal battery is connected to terminal C, the *copper* pole being to earth in the battery room or test box. In cases where it is not likely that a relay will be inserted in a direct writer circuit, a "Down" station can be grouped with an "Up" station, the connections to the instrument being exactly the same as those for an "Up" station.

"Intermediate" direct writers cannot be grouped on a universal battery.

Single Needle Circuits.

Either "Up" or "Down" single needle instruments can be grouped on one universal battery. The connections for an "Up" instrument with ordinary tappers are shown by fig. 80. Each tapper has the left hand end, *h*, of the back spring, *s*, *s*, bent up, so that the tongue, t_1, of the tapper, F, cannot make contact with it when the latter is depressed. Also the front screw, *d*, of the right hand tapper, E, is removed, so that on the depression of the latter no contact is made with the left hand end of the spring, *v*, *v*. The

Action of the Ordinary Tappers

is as follows :—Supposing the left hand pedal, R, to be depressed, then the copper pole of the battery, being in connection with the back spring, *s*, *s*, becomes connected through the left hand end of the latter with the tongue, *t*, of the tapper, and thence through the hinge block with terminal, T, and from there through the dial of the instrument on to terminal B and the Down line. The middle of the battery being to earth, the circuit of the left hand portion of the former is complete, and a *copper* current flows out to line. The screw, *d*, being removed, the copper pole of the battery remains disconnected. If the right hand pedal, F, is depressed, then the zinc pole of the battery, being connected to the front spring, *v*, *v*, becomes connected through the left hand end of the latter to the cock, *g*, and thence through the spring underneath the tapper with the terminal, T, and thus a *zinc* current flows to line.

The equalising resistances, if required, are placed in the battery leads as shown at R.

The alterations to the tappers at a "Down" station are the same as at an "Up" station, and the line and earth connections are made as for an Up station, but the battery and coil connections are reversed.

No alterations to the tappers or connections are required for "Intermediate" instruments. The arrangements are exactly the same as for ordinary working, only the universal battery earthed in the middle is used instead of the ordinary battery.

The general arrangement of an "Up," "Down," and "Intermediate" instrument grouped on a universal battery is shown by fig. 81.

With further reference to the "Intermediate" instrument, it will be seen that its action is very similar to that for ordinary working—that is to say, when a tapper is depressed the zinc becomes connected to the "Up" line, and the copper to the "Down" line, though the battery being earthed in the middle, the currents flowing to the "Up" and "Down" lines respectively are those obtained from each half of the battery working independently. In order that the currents may be equal in both lines, the resistances on each side of the whole battery should be equal, and this will be the case when the resistance of the "Up" line, added to the resistance of the coil, is equal to the resistance of the "Down" line. Care should therefore be taken that this is the case. It is not advisable to produce this equality by putting an artificial resistance in either the "Up" or "Down" line, as it would reduce the strength of the received signals. Unless, therefore, an intermediate circuit can be selected, whose line resistances are such as to nearly satisfy the foregoing conditions, it is not advisable to group it on a universal battery.

The number of cells required for Intermediate instruments is the same as that which was required previous to the conversion to the universal system, since each half of the battery works only half of the entire line at a time. This fact must be taken into

account in calculating the amount of the balancing resistances to be inserted in the battery leads. Thus, for example, if a terminal single-needle instrument be worked on a line of 1,000 ohms resistance, this being the highest resistance of the group, then if an intermediate instrument be worked with the same group, and the resistance of the "Down" line be 700 ohms, and of the "Up" line and coil also 700 ohms, the levelling resistances in the battery leads of the Intermediate instrument would have to be 50 ohms; for $700 + 50 = 750$, which is 25 per cent. less than 1,000 ohms, the resistance of the longest line.

The line resistances referred to of course include the instruments in circuit beyond the station at which the universal battery is placed.

The arrangement of the connections, &c., for the "Bell" form of tapper, when the latter is used for universal working, is shown by fig. 82. For this purpose the straps, f, f_1, connecting s_1 with s_2, and s_3 with s_4, are cut, and the wire joining A with A_1 is removed. If the line requires to be levelled this is done by a single resistance, R, connected between T and A; if no levelling resistance is required, terminals T and A must be connected by a piece of wire.

The connections shown are those for an "Up" instrument, and it should be noticed that the copper of the battery is connected to Z, and zinc to C.

Action of the Bell Tappers.

Supposing the left hand tapper to be depressed, then the tongue, t, presses away the spring, S, from the screw, a, connected to the bridge piece, H, and thus disconnects the line from earth. When the tapper is quite depressed, then the copper pole of the battery is connected through the medium of the spring s_1, and the screw, b, at the end of it, with the brass strip to which terminal A is connected. The current then flows through the resistance, R, to terminal, T, and through the coils to the "Down" line, since the circuit of the left hand half of the battery is complete.

If the right hand tapper is depressed, then a similar action takes place, only the zinc pole of the battery now becomes connected to line through the resistance R.

When a signal is "received," then the current after passing from B through the coils, passes from terminal, T, along the spring, T, to the contact screw, a, and from thence through the bridge, H, to earth.

At a "Down" station the battery and coil connections must be reversed.

Bell tappers cannot be worked on a universal battery at "Intermediate" stations, as the action of the tappers would be to send a current out to both lines at the moment when t or t_1 touched the spring, S, and before the latter broke contact from a.

THE SOCIETY OF ARTS.—Amongst the papers and lectures to be delivered before the Society of Arts during the coming session will be the following:—December 1st, the "Photophone," by W. H. Preece. December 15th, "The Use of Sound for Signals," by E. Price Edwards. After Christmas the following will be amongst the papers and lectures:—"Flashing Signals for Lighthouses," by Sir William Thomson, F.R.S. Four lectures on "The Scientific Principles involved in the Electric Light," by Professor W. G. Adams, F.R.S.

Notes.

THE SOCIETY OF TELEGRAPH ENGINEERS.—The first meeting of the autumn session of this Society was held at the Society's rooms, 4, Broad Sanctuary, Westminster, on Wednesday, November 10th, when a reception was given by the President (Mr. W. H. Preece) on the occasion of the opening of the Ronald's library. A large number of visitors were present. Amongst the exhibits was the American Rapid Telegraph system, which was exhibited in operation. The Ronald's Telegraph, constructed in 1814, was also shown. Mr. Latimer Clark exhibited a number of rare and curious works on electricity dating back as far as the year 1473. The paper to be read before the Society on the 24th inst. will probably be on the "Photophone," by either Mr. W. H. Preece or Professor Graham Bell.

THE ROYAL INSTITUTION.—The lecture arrangements (yet incomplete) for the ensuing season (before Easter) will include the Christmas course by Professor Dewar, and courses by Professors Tyndall and Schafer, the Rev. William Haughton, the Rev. H. R. Haweis, Mr. H. H. Statham, Mr. Reginald S. Poole, and others. Friday evening discourses will probably be given by Mr. Warren De la Rue, Professor Tyndall, Sir John Lubbock, Sir William Thomson, Dr. J. Burdon-Sanderson, Dr. Andrew Wilson, Dr. Arthur Schuster, Mr. Alexander Buchan, Dr. W. H. Stone, and Dr. W. J. Russell.

PHYSICAL SOCIETY, 1880-81.—The meetings of the Physical Society will be held in the Physical Laboratory, Science Schools, South Kensington, on the following days (second and fourth Saturdays in the month), at three o'clock:—November 13th and 27th; December 11th; January 22nd.

LECTURES ON ELECTRICITY.—Lord Raleigh will, during this term, lecture on Galvanic Electricity and Electro-Magnetism, in the Cavendish Laboratory, Cambridge, and Mr. Glazebrook will give an elementary course in electricity and magnetism.

A TELEPHONIC service meter has been invented by Mr. H. L. Bailey, of New York, which enables a telephonic exchange to keep a record of the length of time each subscriber uses his telephone; it also records the number of times each subscriber uses the line. As this has been one of the principal obstacles in the way of the adoption of a combined rental and toll system, instead of the uniform rental system at present in use, we may soon look, if the meter realises the expectations of its inventor, for a change in this respect. In Boston the rental of telephones has been reduced, and a small charge made for each time the line is used. Although the change caused some complaint at first on the part of those who did not understand what it was, the new system is said to give general satisfaction.

A PATENT has just been issued to Mr. J. E. Fenn, of the electrician's department, American Union Telegraph Company, for an important improvement in duplex and quadruplex working. As the Western Union owned the condenser patent, which is a particularly strong one, the American Union found that to enable it to work its long duplex and quadruplex lines it must have a substitute. So Mr. Fenn set about inventing one, and has just secured a patent for the same, as unassailable as is that of the Western Union.

The new device has been in use on the American Union lines for several months, and works to perfection even on quadruplex lines of four hundred miles in length. The American Union is to be congratulated as much on this achievement as on its many other remarkable victories during the past year.—*Operator*.

PROFESSOR A. GRAHAM BELL, in speaking of the future of the photophone, recently said: "It is too soon to speak yet, but I look for its future in a practical use among navigators. For communication of ships at sea, for communication between a lighthouse and a ship, or between a ship that is being wrecked and the people on shore. I also look for it as a means of transmitting messages in times of war, when telegraph lines are down and the country is desolated, and where other electric forms would fail."

GREAT NORTHERN TELEGRAPH COMPANY.—This company proposes to lay down a new cable between Great Britain and the North of Europe. An issue of bonds to the amount of £100,000 is to be made by the company for the attainment of this object.

TELEPHONY IN GERMANY.—The German Post Office authorities are said to contemplate the establishment of a network of telephonic communication for Hamburg and its neighbourhood similar to that recently instituted in Berlin. The tariff will be 200 marks a year for communication of two kilometres in lengths, and 50 marks for every further kilometre.

THE electric conductivity of gas-carbon and its variability under pressure has been re-examined by MM. Naccari and Pagliani. Carbon prisms were carefully covered at certain points of their surface with copper by electro-deposition to secure good contact with the wires by which they were inserted in a Wheatstone's bridge to determine their resistance. When subjected to great pressures the resistances of the rods of carbon showed scarcely any change. Hence it appears that the changes of conductivity which carbon exhibits in the microphone and in the carbon telephone under varying pressures are due not to any alteration of the contact between the particles in the intimate structure of the substance, but to mere changes in the external contact.

DR. WERNER SIEMENS has lately described to the Berlin Academy a new series of experiments on the electric conductivity of carbon, and the way it is affected by temperature. He finds that of gas retort carbon at 0° C. 0·0136 (mercury = 1), and the coefficient of increase of conductivity 0·000345 per degree Celsius. The artificial carbon rods produced by compression of carbon powder also show greater conducting power with increasing temperature, but the increase is not so great (as in retort carbon). Dr. Siemens thinks other experimenters may have been led to erroneous results by faulty connections. He effected the union of the carbon ends with the conducting wires by means of galvanic coppering. The property of conducting better at higher temperatures is regarded as a property of the carbon material itself, not as a consequence of its structure. It may be explained (Dr. Siemens says) as in the case of crystalline selenium, if we assume that the carbon is an allotropic modification (containing latent heat) of a hypothetical metallic carbon.—*Nature*.

ONE of the most brilliant displays of aurora borealis ever seen was witnessed in the Orkney Islands on November 3rd. While the Northern horizon was one dense, dark mass of cloud, with sharply defined edge, the aurora shot up in beautiful coloured streams to nearly the zenith, covering the sky from north-east round to the north-west. Occasionally the aurora took the form of a gigantic rainbow, and the light was as bright as moonlight.

THE ELECTRIC LIGHT ON THE DISTRICT RAILWAY.—The lighting of the Charing-cross Station of the District Railway by the electric light for the first time took place on the 3rd instant. Some time ago an experiment was made by the District Railway Company in lighting their station at Victoria by the Jablochkoff candle. This experiment having proved entirely successful during a period of six months, the directors of the railway have made arrangements with the French Société Génèrale d'Electricité, by which the new illuminating medium will be permanently employed at three of the most important stations upon their line, that is to say, at Charing-cross, Victoria, and Earl's-court. Much interest was shown in the trial, and a number of gentlemen of scientific or official distinction were present upon the platform; among them Lord S. A. Cecil, M. Jules Gaudet, manager of the Société Générale d'Electricité, Admiral Sir W. Hewett, Sir W. R. Robinson, and Dr. Dugald Campbell, the three last named being directors of the new Electric and Magnetic Company, who take over the patent rights in M. Jablochkoff's invention for England and its dependencies. The interior of the station is lighted by the agency of several lamps with opaque glasses, four upon the down platform, and three on the opposite side. An automatic contrivance only recently introduced insures the lights against the possibility of sudden extinction. Should one of the candles by any chance go out, immediately another takes its place, igniting instantaneously. Each lamp is provided with six of these candles, and by this means is made to burn for twelve consecutive hours without replenishing. The motive power is furnished by a 20 horse-power engine, which has hitherto served to supply the electric current to the lamps upon the Thames Embankment, and which now provides in this way for no fewer than 65 lamps, of which 10 altogether are in use at the Charing-cross Station. With regard to the question of the cost of the light as compared with its rival, gas, the Electric Company state that it shows a saving of about 25 per cent., each electric lamp, equal to 1,000 standard candles, costing 2½d. per hour.

THE directors of the North British Railway have determined to adopt Crompton's system of electric lighting in their Queen Street Station, Glasgow.

NEW RECORDING GALVANOMETER OF G. M. HOPKINS.—In making galvanometric tests it is often desirable to consider the element of time, but, as every electrician knows, to do this with the ordinary appliances is tiresome, and the result is liable to be inaccurate. The extreme delicacy of the action of the galvanometer renders it difficult to apply to it any device capable of recording the movements of the needle without interfering more or less with its action. Only two methods of making the record have presented themselves to the inventor—one contemplates the use of photography, the other the application of a disruptive spark from an induction coil. The former is considered too slow; the latter has been adopted and applied to an ordinary vertical galvanometer. The helices are wound with rather coarse wire (No. 22). The needle is astatic, the inner member swinging in the central opening in the helices in the usual way, the outer member being located behind the helices. The arbor supporting the needle has very delicate pivots, and carries a long aluminum index, which is counterpoised so that it assumes a vertical position when no current passes

through the helices, and the needle is unaffected by terrestrial magnetism. The upper end of the index swings in front of the graduated scale, and is prolonged so as to reach to the middle of a cylinder carrying a sheet of paper upon which the movements of the needle are to be recorded. This cylinder is of brass, and its journals are supported by metal columns projecting from the base upon which the other parts of the instrument are mounted. The scale is supported by vulcanite studs projecting from the columns, and to one of the columns is attached a clock movement provided with three sets of spur wheels, by either of which it may be connected with the arbor of the cylinder. One pair of wheels connects the minute hand arbor of the clock with the cylinder, revolving the cylinder once an hour; another pair of wheels connect the hour hand mechanism with the cylinder, so that the latter is revolved once in twelve hours; while a third pair of wheels gives the cylinder one revolution in six days. This instrument is designed especially for making prolonged tests of different batteries in order to determine their characteristics. It is provided with four binding posts, two of which connect the wires of the batteries under test with the helices. The other binding posts are connected respectively with the posts supporting the needle and with the journals of the recording cylinder. These posts receive wires from an induction coil capable of yielding a spark from one-eighth to one-quarter inch long. The induction coil is kept continuously in action by two Bunsen elements, and a stream of sparks constantly pass between the elongated end of the index and the brass cylinder, perforating the intervening paper, and making a permanent record of the movement of the needle. To render the line of perforations as thin as possible, the end of the index is made sharp and bent inward toward the cylinder. The spur wheels are placed loosely on the arbor of the cylinder, and the boss of each is provided with a set screw by means of which it may be fixed to the arbor. This arrangement admits of giving to the cylinder either of the speeds, as may be required. The paper upon which the record is to be made is divided in one direction into degrees and in the other into hours and minutes. The hour and minute lines are curved to coincide with the path of the end of the index. The greatest strength of current being indicated by the greatest deflection from the central line of the record sheet, the approach of the index toward the central line indicates a diminution of the current, which is faithfully recorded by the passing sparks. These records may be duplicated by using the sheet as a stencil and employing the method of printing used in connection with perforating pens. When the tests are of long duration the action of the induction coil is rendered intermittent by an automatic switch connected with the clock. This method of recording may be applied to the electrical dynamometer, to electric meters, and to the more delicate galvanometers; and substantially the same device may be applied to recording thermometers, barometers, and other delicate meteorological instruments.—*Scientific American.*

APROPOS of Professor Graham Bell's experiments, C. Cros, in *Comptes Rendus*, says that since light in passing from one medium to another of different density (separated from each other by a surface oblique to the direction of the rays) undergoes a deflection, we may infer that if the medium acts upon it, it must in turn act upon the medium. The author, therefore, affirms that light tends to assimilate the density of the medium which it traverses to that of the medium whence it has issued. It tends to displace the transparent body in an opposite direction to the deviation which it undergoes. In case of reflection the reflecting body undergoes repulsion.—*Chemical News.*

THE *Popular Science Monthly* for November contains papers on "The Electric Burglar Alarm," "Henry and Faraday," by Professor A. M. Mayer, and "Education as a Hindrance to Manual Occupations," by Professor Sylvanus P. Thompson.

AT the evening concerts being organised at the gardens of the Palais Royal, the orchestra is to be placed near some fountains illuminated by eight magnificent lamps of Siemens. Two other Siemens' lamps have been placed under the galleries in the Magasin d'un Joaillier. It is probable that after this experiment the whole palace will be lighted by electric light.

THE Commissioners of Sewers were to have been asked on Tuesday last to adopt the tenders of the Anglo-American Company (Brush), of the Electric and Magnetic Company (Jablochkoff), and of Messrs. Siemens Brothers, for lighting by electricity three large districts of the City of London, at a cost for twelve months of £5,060. The matter was, however, adjourned.

PRODUCTION OF ALCOHOL BY AN ELECTRIC CURRENT.—Berthelot's experiment was recently conducted in the following manner:—A battery of eight Bunsen elements was connected with an oscillating commutator, so that from twelve to fifteen currents were sent in alternate directions per second, which were conducted to two electrodes of spongy platinum. The platinum cylinder was placed in acidulated water, and the contact action so arranged that neither oxygen nor hydrogen were given off, but the decomposed water regenerated as rapidly as it had been split up. When all had thus been arranged, the two electrodes of the apparatus were immersed in a watery solution of glucose. In this way alcohol was obtained, although, it is true, in but small quantity. It is hoped, however, by modifying the apparatus that the process may be improved and even made of technical importance.—*Chem. Central Blatt*, 1880, 288.

WE notice that an order has been made for compulsorily winding-up the "Navigating Telegraph Company (Limited)," mentioned in our issue of March 1st of this year as having been incorporated.

TELEPHONIC communication has been established between Manchester and Liverpool, a distance of about thirty miles. Congratulatory messages passed between Alderman Thomas Baker and Alderman W. B. Forwood, Mayors of Manchester and Liverpool respectively. Bell telephones with Blake transmitters are used.

New Patents—1880.

4341. "An improved electrical apparatus for operating bells, signals, and telegraphs." G. SKRIVANOFF. Dated October 25.

4391. "Improvements in means for measuring the amount of electrical current flowing through a circuit, which is denominated a webermeter." P. JENSEN. (Communicated by T. A. Edison.) Dated October 27.

4393. "Electric lighting apparatus." W. R. LAKE. (Communicated by H. S. Maxim.) Dated October 27.

4428. "Electric lamps." J. H. JOHNSON. (Communicated by A. Berjot.) Dated October 29.

4434. "Telegraphic recording apparatus." T. M. Foote. Dated October 30.

4441. "Improvements in alarms and indicating apparatus for boilers, cisterns, tanks, ventilators, and the like." F. King and G. Green. Dated October 30.

4444. "Electric gas-lighting apparatus." H. H. Lake. (Communicated by F. W. Pelton.) Dated October 30.

4482. "Cables for telephonic purposes." E. George and J. B. Morgan. Dated November 3.

4495. "Electric-lighting apparatus." W. R. Lake. (Communicated by J. V. Nichols.) Dated November 3.

4515. "Imparting electric currents to fluids whilst passing into the mouth." J. Dunbar and R. R. Harper. Dated November 4.

4564. "Improved thermometers and barometers with electric scale." E. Edmonds. (Communicated by O. Koch and A. Eichhorn. Dated November 6.

4581. "Telegraph receiving apparatus." J. W. Fuller. Dated November 8.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

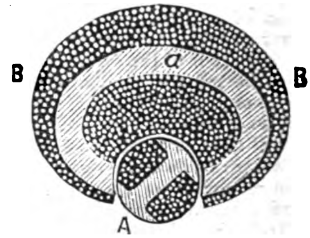
905. "Covering wire with insulating material," &c. J. C. L. Loeffler. March 1. 2d. Relates to the covering of wire with insulating material, such as gutta-percha or other plastic substance, in such a manner as to obtain two or more layers of covering on the wire at one operation. A die is formed with central holes of successively larger diameter through which the wire is caused to travel. To the space between each pair of these holes is provided lateral passages for the plaster material, so that as the wire travels along it receives first one layer of covering, and after passing through the first hole it receives a second, and so on. (Void by reason of the patentee having neglected to file a specification in pursuance of the conditions of the Letters Patent.)

1212. "Electrical fire alarms." C. E. Spagnoletti. Dated March 20. 6d. (*See* page 381.)

1234. "Galvanic batteries." A. M. Clark. (A communication from N. E. Reynier, of Paris.) Dated March 22. 1s. Relates to batteries similar to those described in *Telegraphic Journal*, page 271, vol. viii.

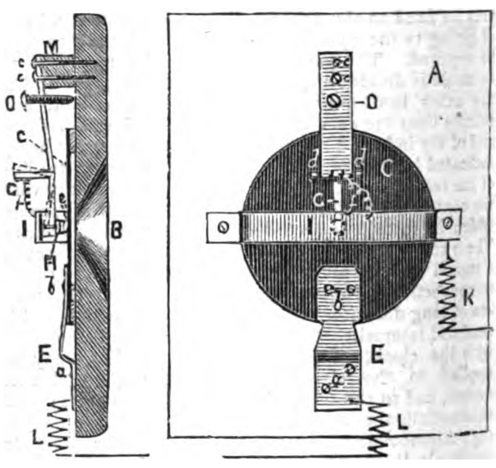
1244. "Regulating electro-magnetic motors, and apparatus employed therein." John Henry Johnson. (A communication from W. W. Griscom, of Philadelphia, U.S.) Dated March 23. 6d. The plates of the battery driving the motor are connected to a treadle, by the depression of which the plates can be lowered to a greater or less depth in the exciting solution, and thus the strength of the current and consequent speed of the motor be regulated. The plates are drawn upwards by means of a spring.

1259. "Electro-magnetic motors and dynamo-electric machines." John Henry Johnson. (A communication from W. W. Griscom, of Philadelphia, U.S.) Dated March 24. 6d. Relates chiefly to the construction of the electro-magnetic of the motor or dynamo-machine, by which the free magnetism distributed over the magnet is utilised, as well as that concentrated at the poles. The core, *a*, of the magnet, B, as illustrated in the figure, is made of a form which may be said to represent a tube, the continuity of which is interrupted by a longitudinal slot extending from end to end of the tube, and in this slot a rotating armature, A, is so arranged that while the poles of the magnet are on opposite sides of the armature, in line with its axis, the entire body of the magnet with its poles shall closely envelop or surround a portion of the rotary armature in the direction of rotation, as shown in the drawing, the object being to so construct the magnet that all its parts will be as near as practicable to the armature, so



that all parts of the magnet will exert their maximum effect, and the helices are arranged in such a manner as to exert their full force upon one another.

1286. "Telephones." J. H. Johnson. (A communication from C. Marx, F. Aklemm, and J. Kayser, of New York, U.S.) Dated March 27. 6d. Relates to an improved telephone transmitter which is not affected by variations of temperature or other disturbing causes. A is the front of an ordinary transmitter box, and B the bevelled opening or mouthpiece leading to the diaphragm, C; the latter is held in contact with a felt or other suitable damping ring or shoulder, D, by



means of a metallic spring arm, E, which is secured at one end by screws, *a*, *a*, to the front piece, A, and by screws, *b*, *b*, at the other end to the diaphragm, so that the arm, E, is practically a spring hinge. On the opposite side to this spring hinge is secured to the piece, A, a practically rigid metallic arm, F, which is fastened in place by screws, *c*, *c*. The free end of this arm is bifurcated or mortised, and in the mortised portion is pivotted by adjustable screw pivots, *d*, *d*, a knee or metal angle piece, G, to the lower extremity of the vertical leg of which is secured in any suitable manner

a carbon button, H, which is kept in contact with the platinum point, *e*, in the centre of the diaphragm by the gravity of the horizontal leg of the knee. I is a metal bridge secured to the piece, A, at right angles preferably to the arm, F, and this bridge and the knee, G, are electrically connected by a conducting wire, *f*, the other necessary connections being made by wires, K, L, from the one end of the bridge, I, and the end of the spring hinge, E, respectively. The arm, F, is secured to the piece, A, by a post or block, M, and screws, *c*, *c*, and with its lower end inclined towards the diaphragm; O is a screw which has a thread bearing in the arm, F, and its end in contact with the piece, A, or a bearing block secured thereto, so that the inclination of the said arm may be slightly adjusted or varied by the act of turning the said screw. The necessary connections to the induction coils, &c., are made in the ordinary manner.

1295. "Insulating electrical conductors." E. M. Allen. (A communication from A. A. Knudson and F. L. Kane, of Brooklyn, U.S.) Dated March 30. 6d. Relates to an insulating coating for enveloping and protecting electrical conductors, more especially such conductors as are designed for telegraphic purposes, and are therefore required in some instances to be suspended in the air, and in other cases to be buried in the earth or submerged in water. The invention consists in applying to the conductors a covering of fibrous material, which is saturated with a compound composed of native bitumen or asphaltum having paraffin oil or residuum of petroleum or candle tar mixed therewith, which not only forms a more efficient, durable, and permanent insulating material than any which has heretofore been employed for similar purposes, but which can be prepared at a much smaller cost.

1328. "Telegraphic and telephonic apparatus." W. R. Lake. (A communication from E. Davis, of Chicago, and P. A. Dowd, of Boston, U.S.) Dated March 31. 1s. By this invention a certain station (for example, the central office), can call any one of a large number of stations in one circuit, without at the same time sounding the bells or giving other signals at the other stations in the circuit; each station can call the central office without sounding the bells at the other station in the same circuit; each station can communicate with the central office and with any other station; the central office can communicate with any station without the knowledge of the other stations; any of the stations can be connected in order that they may communicate each with the others, and without the knowledge of any station not connected; and the system and apparatus used can be made simple, durable, and not easily deranged. In this invention, one heavy current, one light current, and one heavy current will so move the parts of one of the instruments as to sound the alarm, but will not thus move any other instrument in the series; one heavy, two light, and one heavy will cause another instrument, say, at station two, to signal, but will not cause the instrument at any other station to signal; one heavy, three light, and one heavy will sound the alarm at station three, but no other; one heavy, four light, and one heavy at station four, and no other, and so on, no signal being sounded, except when its own peculiar series of currents pass over the main circuits.

1333. "Machinery for the manufacture of engine-packing and insulated telegraph wires." G. F. James. Dated March 31. 6d. Has for its object both the lapping and braiding or plaiting of any desired number of threads or strands or series of laps or braidings round any desired central core in one and the same machine, and consists in so arranging the lapping spindles and the braiding spindles in the same framework, and by preference to revolve round the same axis, that the core, say, after being lapped, is then taken through one or more series of braiding spindles, which braid a corresponding number or coatings of braid upon such lapped material.

1339. "Rotary induction or electric motor." J. C. Mewburn. (A communication from W. de Fonvielle, of Paris.) Dated April 1. 2d. Consists—1st, of a galvanometric frame of any suitable form, on which are wound a number of turns of one or more insulated electric wires; 2nd, of a motor mounted on a pivot or axis and situated in the centre or at the top or bottom or in proximity to the galvanometric frame, so that the requisite action can be produced. It is formed of a piece of magnetic or magnetisable metal, either solid or hollow, which is put into motion by the action of the current circulating through the spirals of the galvanometric frame; and 3rd, of magnets grouped or arranged in suitable position around the motor. (*Provisional only.*)

1343. "Apparatus for the production and application of electricity and magnetism." Louis Pulvermacher. Dated April 1. 8d. Relates to improvements in the inventor's well-known chain batteries.

1392. "Dynamo-electric machines." W. R. Lake. (A communication from H. S. Maxim, of Brooklyn, U.S.A.) Dated April 5. 8d. Relates to a device for regulating dynamo-electric machines in respect to the amount of electricity generated, so as to render the electro-motive force of the current constant at each point of consumption (*see* page 382); it also relates to improvements in the construction of the armature and commutator of such machines.

1397. "Electric lamps." C. D. Abel. (A communication from F. Krizik and L. Piette, of Pilsen, Austria.) Dated April 6. 6d. Relates to a method of effecting automatically the regulation of the distance of the carbons in an electric lamp, without the aid of clock-work, or other like mechanism, by the use of solenoids having special cores, such solenoids and cores being applicable where, as in electric lamps, uniformity of attractive force has to be maintained throughout a considerable length of stroke.

1407. "Electrical conductors for telegraphic and telephonic purposes." Oliver Heaviside. Dated April 6. 6d. Has for its object the rendering of a circuit completely independent under all circumstances of external inductive influences. For this purpose two insulated conductors are used for the circuit and one is placed inside the other. Thus, one conductor may be a wire and the other a tube or sheath, thus forming a compound conductor consisting of a central wire surrounded by an insulating covering, which is in its turn surrounded by a conducting tube or sheath which must also be insulated.

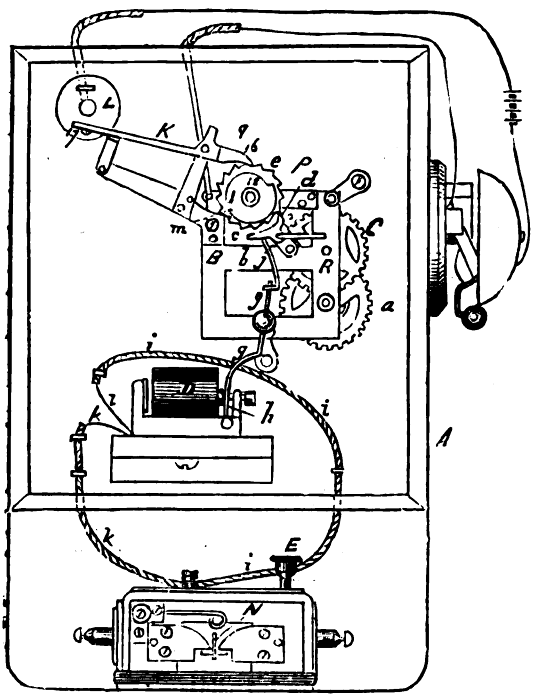
2136. "Signal apparatus for telephonic or telegraphic purposes." W. R. Lake. 6d. (A communication from abroad by Charles Sumner Eaton, of Lowell, Massachusetts, U.S.A.) Relates to call or signal apparatus for telephonic or telegraphic purposes.

Where a number of telephones are included within a single electrical circuit, as heretofore, and the operator at one station wishes to communicate with another station, he sounds on the electric signal or call-bell of the receiving station the number by which it is designated to call the attention of the attendant at that station. As, however, the signal bells of all the stations are in the same circuit the signal is sounded simultaneously at every station, causing a great annoyance by

reason of the frequent ringing of the bells, and the necessity for the attendant at each station to be constantly on the alert, in order to distinguish the different signals and recognise that of his station, so as to know when it is called.

To avoid this simultaneous ringing of all of the signal bells of the different stations in an electrical circuit, and to cause only the bell at the particular station to which the message is to be sent to be sounded while the others remain silent, is the object of this invention.

The figure is a front elevation of the improved call or signalling apparatus. *c* is a train of clockwork actuated by a spring, *a*, and provided with a "dead beat" escapement. The plate *b* (carrying at its ends the pallets, *c*, *d*, which engage with the teeth of the escapement-



wheel, *e*), is provided with a rod or wire, *f*, which is attached to its under side, and is vibrated by an arm, *g*, projecting up from the armature, *h*, of an electro-magnet, D, the upper end of the arm, *g*, passing through a loop at the lower end of the rod, *f*. The electro-magnet, D, has its coils connected with the main line wire, and can be worked by means of a key, E, at each station.

To the outer end of the arbor, *m*, of the escapement-wheel, *e*, is secured an index-hand or pointer, which moves over a dial, bearing on its face the numbers of the telephone stations in the circuit. Upon the arbor, *m*, is also secured a wheel or disc, I, provided with a notch, *p*, and against the periphery of the disc, I, rests one end, 16, of a nearly balanced lever, K, having its fulcrum at *q*, the opposite end, 17, of this lever being so placed as to come into contact with a metallic stud or post, L, when its end, 16, is allowed to drop to, or nearly to, the bottom of the notch, *p*, in the disc, I, this contact of the end, 17, of the lever, K, with the stud, L, completing a local circuit, in which the call-bell, M, is included, and giving an alarm to notify the attendant that it is desired to communicate with his station.

The notch, *p*, of the disc, I, is so placed with respect to the index-hand and dial that the end, 16, of the lever, K, will drop into it to close the bell-circuit and give the alarm only when the index-hand points to a particular part of the dial corresponding to the number of the station to which the instrument belongs; and to close the bell-circuit when the hand is in the position referred to, the operator at the transmitting station must keep the key, E, depressed a sufficient length of time to give the end, 16, of the lever time to drop to, or nearly to, the bottom of the notch, *p*, so that its opposite end, 17, will strike the stud, L, otherwise the call-bell will not be rung. When, however, the operator removes his finger from the key, E, allowing it to rise, the circuit through the electro-magnet, D, is closed, and the disc, I, is rotated sufficiently to raise the end, 16, of the lever, K, out, or nearly out, of the notch, *p*, and thus open the bell-circuit and stop the ringing of the call-bell, M. When the notch, *p*, of the disc, I, is carried rapidly past the end, 16, of the lever, K, which is effected by releasing the key, E, instantaneously after each depression, the end, 16, will not have time to drop into the notch, *p*, sufficiently far to bring the other end, 17, of the lever into contact with the stud, L, but will be caught by the inclined portion, 18, of the notch, *p*, and again raised up before the end, 17, can come into contact with the stud, and consequently the call-bell, M, will not be sounded. This rapid movement of the notch, *p*, of the disc, I, past the end, 16, of the lever, K, will occur when some other station in the circuit is being called, which will necessitate the revolving of the notch, *p*, past the end, 16, of the lever.

The following are the final quotations of telegraphs for the 11th inst.:—Anglo-American Limited, 61¾-62¼; Ditto, Preferred, 91½-92½; Ditto, Deferred, 32-32½; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9¾-10; Cuba, Limited, 8¾-9¼; Cuba, Limited, 10 per cent. Preference, 16-16½; Direct Spanish, Limited, 2⅝-3⅛; Direct Spanish, 10 per cent. Preference, 12¼-12¾; Direct United States Cable, Limited, 1877, 11¾-12; Scrip of Debentures, 101-103; Eastern, Limited, 9⅝-9⅞; Eastern 6 per cent. Preference, 12⅛-12¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 103-107; Eastern 5 per cent. Debentures, repayable August, 1887, 103-105; Eastern, 5 per cent., repayable Aug., 1899, 105-107; Eastern Extension, Australasian and China, Limited, 9⅞-10⅛; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 105-107; Ditto, registered, repayable 1900, 106-108; Ditto, 5 per cent. Debenture, 1890, 101-103; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 102-104; Ditto, ditto, to bearer, 102-104; German Union Telegraph and Trust, 9¾-10¼; Globe Telegraph and Trust, Limited, 6¼-6¾; Globe, 6 per cent. Preference, 12-12½; Great Northern, 10⅝-10⅞; Indo-European, Limited, 24-25; London Platino-Brazilian, Limited, 4¾-5¼; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 11-11½; Submarine, 250-260; Submarine Scrip, 2⅜-2⅝; West Coast of America, Limited, 3-3¼; West India and Panama, Limited, 1¼-1½; Ditto, 6 per cent. First Preference, 6¼-6¾; Ditto, ditto, Second Preference, 5¾-6¼; Western and Brazilian, Limited, 7⅞-8⅛; Ditto, 6 per cent. Debentures "A," 106-110; Ditto, ditto, ditto, "B," 97-100; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 118-122; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 34½-35; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3⅜-3⅝; India Rubber Company, 17-17½; Ditto 6 per cent. Debenture, 106-108.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 188.

ELECTRIC LIGHTING IN THE CITY.

THE most extensive trial of the electric light for public purposes yet made will, about the 1st of February next, be inaugurated in the City of London, as the City Commission of Sewers have adopted a report of the Streets Committee recommending that the tenders of the Anglo-American Light Company, of the Electric and Magnetic Company, and of Messrs. Siemens Brothers be accepted. The first company will undertake the lighting of Blackfriars Bridge, Bridge Street, Ludgate Hill, St. Paul's Churchyard, and Cheapside to King Street, by the Brush system, at a cost of £1,410 for 12 months. The second company will light Southwark Bridge, Queen Victoria Street, and Queen Street, by the Jablochkoff system, the cost being £2,930 for 12 months. Lastly, Messrs. Siemens will light London Bridge, Cheapside (from King Street, Mansion House Street, and King William Street), at a cost of £3,720 for the 12 months.

On a rough calculation, taking all the districts together, the cost (including the plant, machinery, fixing and replacing, &c.), will be about four times the price now paid for gas-lighting; but eliminating those expenses, which would not be recurring, the cost would be only twice that of gas, while the amount of light produced will be very much greater.

Messrs. Siemens are the only contractors who propose to bury the conductors wholly underground. There can be little doubt but that the latter is the proper course to adopt. Open conductors slung from lamp to lamp, or post to post, are very unsightly in broad daylight, as any one walking along the Thames Embankment can testify. If any system is permanently employed, underground wires will certainly have to be used, and we think the Commissioners should have insisted upon this course being followed in accepting any of the contracts.

A great deal has been said about the relative values of a large number of small lights compared with a small number of large lights: the coming trial will severely test this question, as the number of electric lights will be very much less than the number of gas jets they are to displace; thus, although there may be a brilliant illumination at points, the intermediate spaces will possibly be wanting in light. According to the tenders, 449 gas lights will be replaced by 116 electric lights, or roughly, 1 electric light will take the place of 4 gas lights, so that the space between each electric light will be four times that between each gas lamp. In order, therefore, that the intermediate points between each electric lamp may be illuminated to the same extent as was the case when the gas lamps existed, the intensity of the illumination from each electric lamp will have to be correspondingly great, it being recollected that the intensity of a light diminishes as the square of the distance it is from the object it illuminates. In other words, the light from each electric lamp will require to be sixteen times as great as that given by the gas jets. There are, of course, other considerations which come into play, and which practically modify the theoretical calculation, but the importance of estimating lighting power by space illuminated and not by candle-power cannot be too strongly urged.

THE HYDROSTATIC TELEGRAPH.

By MAURICE GIRARD.

CERTAIN of our streams and rivers have excessive rises, so sudden that they cannot be announced to the borderers in time sufficiently early to enable preparations to be made for avoiding the same. Thus at Toulouse, in 1876, the prodigious mass of water of the Garonne, which without notice inundated the lower part of the town, came from a very long distance, when it suddenly submerged the unfortunate Faubourg St. Cyprian; it had rolled forward for more than twenty hours, and it had spread over more than forty-five leagues over a country well provided with telegraphs. However, it was not announced in any way when it reached Toulouse, where it swallowed up hundreds of human lives and did enormous damage.

It is to avoid such a terrible event that M. C. Gros, of Rodez, has sought to solve the following problem: To keep the borderers *continually* informed of the state of the river as regards its rises, so that precautions may be taken in time to avoid the danger. It was necessary that the apparatus should fulfil certain conditions of economy in order that its employment should be practical. It must, by the variation of the level of the water, set in motion the telegraphic system without the intervention of watchers by day or night, the exactitude of which can be relied upon. Besides, it is necessary that the notice be transmitted to the ordinary telegraph offices so that there is no need of a supplementary supervision, and that the notices can be addressed direct to the borderers or to those interested by the most rapid means of public communications.

The Gros telegraph is composed of three distinct parts: 1st, the transmitter; 2nd, the receiver; 3rd, the wires which connect the two.

The transmitter (fig. 1) is composed of a float, a battery, and a set of oscillating pendulums. The float is a hollow cylinder 50 decimetres in circumference, furnished with a cable, C, C_1, which makes a turn over a pulley, *a*, to which it transmits the movements of the water level. The series of pendulums, *dddd* - - - - - *dddd* (fig. 2), suspended to a pivot, *c*, are actuated by the wheel, *a*, and turn to the right or left according as the float rises or falls. In the first case the pendulums send out a positive current to line, L, and a negative to earth; the reverse movement of the wheel, *a*, makes, on the contrary, a negative current to pass to line and a positive to earth. It can be seen, therefore, that this automatic action caused by the water sends out to line a positive or negative current of short duration, according as the water rises or falls. At the station the receiver, by means of a pointer and dial,

indicates automatically the currents sent, and if the rise of the water is very sudden rings a bell. This receiver (figs. 3 and 4) is simply a double Breguet receiver with certain modifications: 1st, the two driving trains, placed symmetrically, are driven in the reverse direction the one to the other; 2nd, the electro-magnets connected to each clockwork movement are polarised, the one positively and the other negatively; 3rd, there is a single dial; 4th, between the two last wheels, R, R, of the clockwork

the other), which are on the same axis, is caused to turn. The gearing of each of these two last wheels, *r r'*, is such that, driven by the ratchet-wheel, R, it is without action on the other.

The movements of the wheel, O, are limited by a special regulator. This wheel, O, carries a needle, which moves round a graduated dial, and which indicates the height of the water each time that the level of the water changes, whether it be a rise or fall, a distance of 10 centimetres. The same wheel,

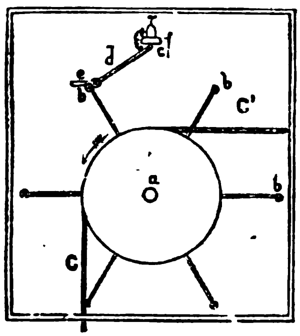


Fig. 1.

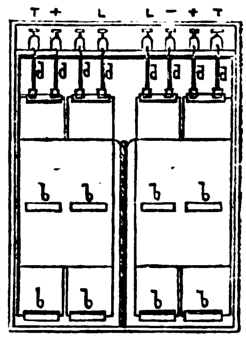


Fig. 2.

Figs. 1 and 2.

Figs. 1 and 2, transmitter; *a*, grooved pulley-wheel; *b*, conducting rods fixed to insulated supports; *c*, axis of pendulums; *d*, pendulum rods; *e*, jointed tongue of pendulums; *f*, terminals; L, line wire; T, earth wire; +, positive pole; —, negative pole.

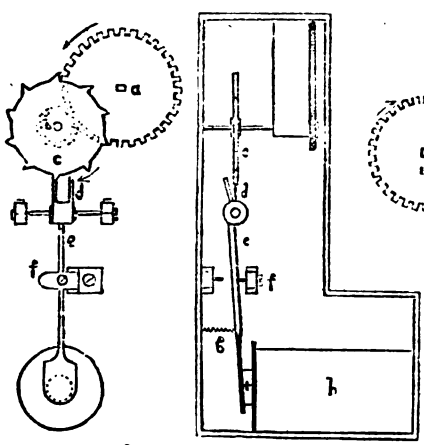


Fig. 3.

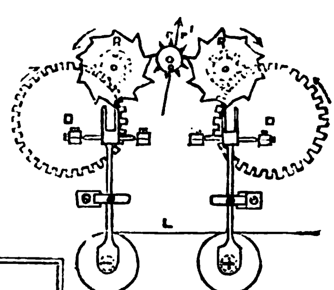


Fig. 4.

Figs. 3 and 4.

a, driving clockwork; *b*, pinion; *c*, ratchet-wheel; *d*, escapement fork; *e*, lever; *f*, stop; *g*, spring; *h*, electro-magnet; O, axis of needle carrying two wheels, *r r'*—these wheels, *r r'*, are set one behind the other R R, ratchet-wheels turning in opposite directions and regulated by the escapement forks, *d*; L, line wire passing round both electro-magnets.

trains (fig. 4) an intermediate wheel, O, is set, which is geared into by one of the two wheels, R, R, the teeth of the latter being so shaped relatively to the teeth of the wheel, O, that the gearing only takes place when one or other of the two wheels turns. As long as the one or other of the movements is allowed to work by the action of the current, the one or other of the two wheels, *r r'* (the one behind

O, transmits its movements to a horizontal clip, which slides between fixed guides, and which carries a soft pencil. In contact with this pencil moves, over a roller, a strip of paper, this strip being moved along by means of a clock. The pencil thus traces, without interruption, the exact curve showing the rise or fall of the water. In case of a sudden rise, when the needle is at a point marked *Danger*, a bell

sounds, either by day or night, and calls the attention of any one who may be near the receiver; a single glance at the dial allows of the height of the water and the degree of danger to be at once seen. A single wire between the receiver and transmitter communicates the indications.

It is easy to understand the advantages of the apparatus of M. Camille Gros. Science is benefited, as the daily observations can be automatically registered, and a mathematical curve of the changes is obtained. The other systems, and particularly the telephone, cannot give this important result. The employé may be occupied or even asleep, the electric-bell announces at once the danger, and the alarm can be spread. Better still, the dial can be placed out of doors; any one can then read from it as easily as from a barometer or clock. By comparing the indications with the information given by a table placed by the side of the instrument, the rapidity of the advance of the water can be known by reason of its volume, each borderer can therefore know at what time the inundation will arrive at his locality. The Gros apparatus thus becomes a true meteorological instrument analagous to those which have been so usefully placed for some time in our towns in order to indicate storm disturbances, and not less useful.

After the description of this hydrostatic telegraph made by the engineer of the Vital mines before the Société des Lettres, Sciences et Arts of l'Aveyron, and on the unanimous recommendation of this Society, the Conseil-Général of l'Aveyron granted the funds for the construction of a first specimen of the system. Experiments took place, at the expense of the State, on the Lot, between Penelot and Capdenac, a distance of 14 kilometres between the transmitter and receiver. They worked perfectly, and it is to be wished that the higher administration will make a statement to this effect.—*La Nature.*

NEW ELECTRIC LAMPS.

GORDON'S ELECTRIC LAMP.

THE inventor has for his object improvements in apparatus for producing electric light. For this purpose he avails himself of a discovery announced by Mr. Spottiswoode, that an induction coil can be excited by a De Méritens or other dynamo-electric machine giving alternate currents, and that in this case no contact breaker or primary condenser is required. To apply this discovery to electric lighting he so modifies the secondary terminals that a light fit for illuminating purposes can be obtained from the secondary discharge. He uses coils of moderate size, and places a number of them on the circuit of the machine, either in parallel circuit or in series, or in a combination of the two.

The inventor breaks the secondary circuit in one or in several places, getting a light at each, so that all the lights or any one coil are in series. Terminals of platinum or other refractory metal are used, and the general form consists of a lump of platinum supported on a thin platinum wire. These lumps become white hot, and the thin stems prevent the heat from being conducted away. A mechanical arrangement is adopted which brings the lumps nearly together (or connects them by a wire or other conductor) when the current is not flowing in the primary coil, and separates them to a short distance when the current commences. The supports of the terminals should be mounted on some soft substance and the lights inclosed in globes, in order to extinguish the noise that otherwise occurs. The advantages of the system, *as claimed*, are, that a great number of lights can be worked from one dynamo-machine, that no carbon or *anything else* is consumed in the lamp, and that the light is perfectly steady and no clockwork is used.

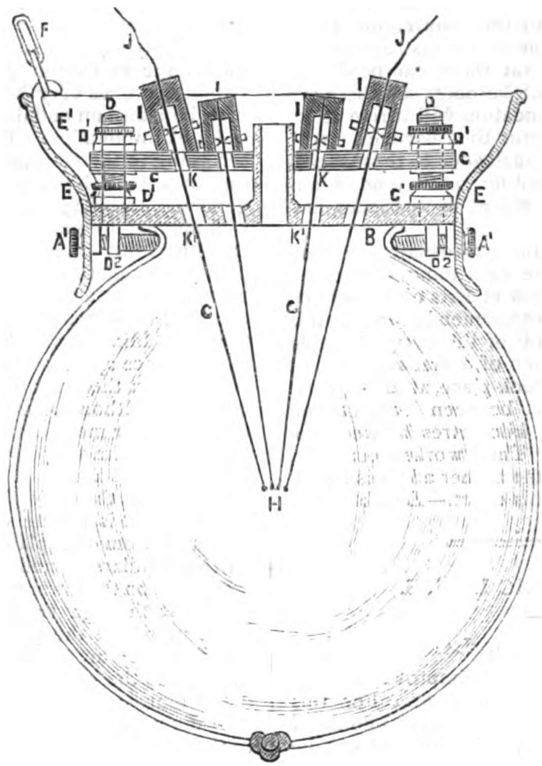
The following form of the lamp has been found to be the most advantageous, but is not the only useful form. Four pear-shaped knobs, each carried by a wire stem, are placed in a line near together, and the two outside ones connected to the conductors supplying the currents. When the discharge passes the two outer get moderately hot and the two inner ones very hot. The two outer knobs may be platinum and the two inner ones iridium or iridio-platinum alloy. The size of the knobs varies according to the strength of the current, from about that of a pin's head to that of a small pea. It is generally advantageous to make all four knobs of iridium, and to make the two outer ones smaller than the inner ones. The stems are preferably of platinum or platinum-iridium alloy, and the inventor uses wires about 2 to 3 inches long or more, and about ·06 inch thick, the object being to have them the thinnest which will be safe from melting. The distance apart of the knobs when cold should be such that they just do not touch when expanded by heat. Although four knobs are commonly used, three, two, or more than four may be used in some cases. The drawing shows a section of an electric lamp of this kind. A is a glass globe held by screws, A¹, to the underside of a plate, B, of glass or porcelain. C is a plate of ebonite carried by brass pillars, D, from the plate, B. D¹ are nuts screwing on to the pillars, D, and holding the plates. D² is a cross head on the lower end of each pillar; the screws, A¹, screw through these heads. E is an opaque shade by which the plates, B and C, may be surrounded. E¹ are arms fixed to the plate, B; by these arms the lamp can be suspended by chains, F. G are four stems of platinum wire with knobs, H, of iridium, on their lower ends. The upper ends of the wire stems are fixed to the caps or solid tops of tubes, I, which are carried by the ebonite plate, C. The two outermost wire stems are coupled by wires, J, to the source of the rapidly alternating currents of the electricity. The suspenders can, if desired, be used as conductors. Through the sides of each of the tubes, I, are screwed three adjusting screws; the ends of the screws bear against the wire stems, and by means of them the knobs at the lower ends of the stems can be held and retained at any required distance apart from one another. There are holes, K, in the plates, B and C, through which the wire stems, G, pass. These holes also serve to admit currents of cool air to the interior of the globe, A. A chimney is provided by which heated air can rise up and escape from the globe.

It is found that much greater tension is required to light the lamps, *i.e.*, to cause the spark to spring between the cold knobs, than to maintain them when lighted. Now, although it is perfectly pos-

sible to produce a current of sufficiently high tension, either by a machine or by an induction coil, to light the lamp, yet it is found that as every increase of tension throws an extra strain on the insulation, it is advantageous to bring the four knobs into contact, or nearly into contact, before the lamp is lighted, and to separate them after the current has begun to pass. This may either be done by hand, by the use of suitable levers, or automatically by a lever or levers acted on by the passage of the electric current, or by the heat generated by it, or otherwise.

The machine should be one that gives rapid and sharp reversals. A separate induction coil may be used for each lamp, or several lamps can be placed

1·3 inch in diameter and 18 inches long. Three layers of insulated wire ·08 inch in diameter are wound on it. The secondary is wound on an insulating tube, and consists of about ⅘ mile of wire, ·0075 inch diameter, covered four times with silk. It is wound in 60 discs. The external diameter of the secondary coil is about 3·5 inches. There are three binding screws, one at each end and one in the centre, so that the whole coil can be used for one lamp or either half separately. The inventor considers that the new light has the following advantages: the accidental destruction of any lamp extinguishes that lamp only, the light is capable of great subdivision, there is no vacuum and no clockwork, and the light is extremely steady.



on one coil as follows: they may be all placed in series, or a better plan is to let each lamp have its own section of the secondary wire. This latter plan makes all the lamps in a coil nearly independent of each other.

The lamps may be lighted and extinguished either by a make and break key in the secondary circuit or by short-circuiting the secondary. Or the lamps may be lighted and extinguished by shunting the primary current on and off the coil, or on and off several coils at once, with or without the introduction of a compensating resistance. To give some idea of the dimensions of the coils the inventor gives the details of one which he has used for one 100 candle lights or two 50 candle lights. The primary consists of a bundle of iron wires

THE PHOTOPHONE.

By SHELFORD BIDWELL.

Our contemporary *Nature* publishes the following:—Many readers of Nature will doubtless be glad to know that Mr. Graham Bell's extraordinary experiments may be repeated on a small scale with very simple apparatus, no special appliances being required beyond the mirror transmitter and the selenium receiver, both of which may be easily constructed. I propose to give a short description of an arrangement which has in my hands been very successful.

The mirror is made of the thin mica which is sold

by opticians for covering *carte de visite* photographs. It is cut by scissors into a circle $2\frac{1}{4}$ inches in diameter, and silvered by the process for silvering glass specula. The box in which it is mounted is an ordinary wood turned box $2\frac{1}{2}$ inches in diameter. A circular hole of about 2 inches diameter is cut in the lid, behind which the mirror is laid with the reflecting side outwards, a flat ring of vulcanised india-rubber of suitable size and thickness being placed behind the mirror; when the box is closed the ring should hold the mirror firmly in position. If the lid screws on, so much the better. At the bottom of the box is cut a hole, into which is glued one end of a flexible speaking-tube 18 inches long, having at its other end a wooden mouthpiece. It will be found convenient to attach a short wooden arm to the box in a direction perpendicular to its axis. By means of this arm the transmitter may be held in a clamp in any desired position. This completes the transmitter as described by Mr. Bell. I have made a small addition which, though not essential, is a decided improvement. At the back of the mirror I cemented a disc of calico 1 inch in diameter, in the centre of which had been previously inserted a loop of silk half an inch long. A hole $\frac{1}{8}$ inch diameter is bored perpendicularly in the side of the box at a point about $\frac{1}{2}$ inch from the mirror end of it, and in this hole is inserted a piece of watch-spring $1\frac{3}{8}$ inch long, with its flat sides parallel to the top and bottom of the box. The spring is fixed into the hole with wooden plugs so that one end is flush with the outer surface of the box; the other end where it intersects the axis is bent into a shallow hook. Into this hook is slipped the silken loop, and the tension of the spring draws the mirror into a slightly concave form, and seems to make it respond more perfectly to sound vibrations.

By far the most important part of the whole apparatus is the selenium "cell." After making some dozens of different forms, most of which were more or less sensitive, but none satisfactory, I tried the one now to be described, which turned out very successful. Take a slip of mica $2\frac{1}{4}$ inches long and $\frac{3}{4}$ inch broad, and beginning at $\frac{1}{4}$ inch from one end, wind round it in the form of a flat screw some No. 40 copper wire. The pitch of the screw is $\frac{1}{16}$ inch, that is, each wire on the two faces of the mica is $\frac{1}{16}$ inch from its neighbours. Continue winding up to $\frac{1}{4}$ inch from the other extremity; then fix the two ends of the wire by passing them through holes drilled in the mica. Now take a second wire and carefully wind this on beside the other, thus forming a second screw, the threads of which are midway between those of the original one. Fix this as before. Great care must be taken that the two wires do not touch each other at any point: it will be well to make sure of this by testing with a galvanometer before proceeding further. If a lathe is at hand, the tedious operation of winding may be very greatly facilitated. Turn a cylinder of hard word $4\frac{1}{2}$ inches long and 1 inch in diameter; cut this cylinder longitudinally into two equal parts, and between the two semi-cylinders thus formed place, sandwich-like, a slip of mica of equal breadth. Secure the ends with screws. Smooth down the whole in the lathe, and when the edges of the mica are quite flush with the surface of the wood, cut upon the cylinder a screw of 32 threads to the inch. On removing the mica from the cylinder its two edges will be found to be beautifully and regularly notched. Wind the first wire into alternate notches, and the second into the others. The wire should be annealed to take away its springiness and make it lie flat, and the mica should be stout enough to bear tight winding without buckling.

For the succeeding operation a retort-stand at least 15 inches high is convenient. Fix one ring 15 inches above the foot; on a lower ring stand a medium-sized Bunsen burner. On the top ring lay a flat sheet of brass $\frac{1}{16}$ inch thick, and on the brass a piece of mica (to save waste selenium). Place the embryo cell on the mica, laying small weights on its two ends to keep it steady and bring it into closer contact. Having brought the Bunsen burner close under the brass, melt a few grains of vitreous selenium in a small spoon and let four or five drops fall upon different parts of the cell. Spread the melted selenium evenly over the surface with a slip of mica, pressing it well between the wires. During this process the temperature must be carefully regulated by raising or depressing the burner. If it is not high enough, the selenium will begin to crystallise; if too high, the selenium will gather up into drops, being apparently repelled from the surface of the cell. The temperature should in fact be just above the fusing point of crystalline selenium. When a smooth surface is obtained, quickly remove the cell with microscope forceps and let it cool. Its surface will now be smooth and lustrous.

The cell must next be annealed. And here my experience differs in a remarkable manner from that of Mr. Bell, as stated in his celebrated lecture. It is true that selenium may be rendered crystalline in "a few minutes," but in this condition I find it far less sensitive to light than after it has undergone a process of long heating and slow cooling. My method is as follows:—The brass plate being cool, lay the cell upon it again, and place the burner at its lowest possible point. The selenium will soon begin to crystallise, as evidenced by its surface assuming a dull leaden appearance. (If the crystallisation has not begun in five minutes, raise the burner an inch or two.) In from five to ten minutes the whole of the selenium should be crystallised. Then very gradually raise the burner until signs of fusion just begin to appear. This will probably take place when the flame is within 3 inches of the brass. Instantly remove the burner, and in about ten seconds re-crystallisation will occur. Now fix the burner $\frac{1}{2}$ inch below the point at which it was when fusion commenced, and let it remain for four hours, merely looking at it from time to time to ascertain that, owing to increase of gas pressure or other causes, the heat has not become too great. After four hours begin the cooling by lowering the burner an inch or two, and repeat this operation every ten or fifteen minutes, until the burner is at its lowest point. Then slightly lower the gas-flame at short intervals, until it is finally extinguished. When the brass plate is quite cool the cell may be removed.

I may mention that I first made a cell of this form, which I believe to be original, on October 28.* If

* If a larger surface is desired, two or more of these cells may placed together side by side, the ends of the wires being prop

the two wires were wound on a cylinder made of some suitable non-conductor (*e.g.*, slate) with a double screw cut upon its surface, a cell might be formed which, it appears to me, would unite all the advantages of Mr. Bell's with far greater simplicity.

My experiments were made with the transmitter and selenium cell above described, a magic-lantern with a 4 inch condenser, the focussing lenses being removed, two plano-convex lenses obtained by separating a 3½ inch condenser, a "blow-through" lime-light, a battery of eleven cells (small Leclanché's answers well), and a pair of Bell telephones. It is essential that the bobbins of the latter be wound with finer wire than that generally used. Mine contain No 40 (instead of 35 or 36), and I intend to try 42. Their diameter is also larger than usual—1¾ inch.

The transmitter is clamped so that its axis is inclined at an angle of about 30° to that of the lantern condenser, the centre of the mirror being 7 or 8 inches from the centre of the condenser; and the position of the lime-light is so adjusted that the condensed rays may just cover the whole surface of the mirror.

The reflected beam is rendered as nearly parallel as possible by one of the plano-convex lenses (this can only be done approximately), while the other, placed a foot or two away, concentrates the light upon the selenium cell, forming an elliptical image of the mirror. The major axis of the ellipse should be parallel to the length of the cell, and the minor axis slightly longer than its width. A great deal depends upon the focussing, and the best results have been obtained when the image of the mirror was not quite sharp. The selenium cell is joined in circuit with the battery and the pair of telephones, the latter being for obvious reasons placed in a distant room. The arrangements are now complete, and a person listening with a telephone applied to each ear will, if everything is right, plainly hear words which are spoken into the transmitter. When I first made the experiment I was so much astonished at the distinctness of the reproduction that I believed that one of the battery connections must be defective, thus acting like a microphone. This was disproved by screening the mirror, when all sound instantly ceased.

Though the articulation is not perfect, it is far better than I had expected, judging from the accounts of the performances of the photophone in Paris. A leading article might not be altogether intelligible, but ordinary colloquial phrases are readily understood. The loudness of the reproduced speech varies in an unaccountable manner. Sometimes the voice is rendered almost as loudly as in an ordinary telephone; at other times, under apparently the same conditions, it is scarcely audible. Alternations from loudness to faintness, and *vice versâ*, frequently occur in a single sentence.

The distances across which the beam is carried have varied in my experiments from 1 foot (when the two plano-convex lenses were in actual contact) to rather more than 4 feet. With a larger receiving lens this distance could be greatly extended, especially if the electric light were used.

connected. The width of ⅜ inch for a single cell cannot be much exceeded, because the expansion produced by the heat necessary for melting the selenium would make the wires on a wider surface so loose as to touch each other.

For the "musical" effects produced by an interrupted beam I use a disc of zinc 1 foot in diameter, having eight radial slits cut in it, and mounted upon a vacuum tube rotator. The cell is placed 6 inches from the lantern condenser, and the disc made to rotate close before it. The sound produced is very loud, and can be heard when the telephones are at a distance of a foot or more from the ears.

It is very singular, that whereas I have been so successful in repeating Mr. Bell's more complex experiments, I have utterly failed in all attempts to produce sound by the simple incidence of an interrupted beam upon a thin diaphragm. I have experimented with discs of ebonite varying from $\frac{1}{64}$ to ¼ inch in thickness, and with several metals, and can only suppose that my source of light is not sufficiently powerful.

THE AMERICAN FAST SPEED AUTOMATIC TELEGRAPH.

SOME trials have recently been made on the Postal Telegraph wires of a fast speed automatic telegraph system, the invention of Mr. T. M. Foote, of Brooklyn, and F. Anderson, of Peekskill, America. Although on the longest circuits the system failed to attain the speed given by the Wheatstone instruments, yet on short circuits very high results were given, and the system therefore merits a description.

As in the Wheatstone instrument, the currents in the transmitting portion of the apparatus are controlled by a perforated slip of paper; the latter is shown by fig. 1.

A peculiarity in the system consists in the fact that each signal is formed by either one positive or one negative current, and that two currents of a like sign never immediately follow one another—that is to say, a positive current always follows a negative, and a negative a positive current.

The perforated slip is passed over a metallic roller, W (figs. 2 and 3), which is divided into two insulated halves, which are respectively connected to the zinc and copper poles of a split battery earthed in the middle. Two brushes, b, b^1, both connected to line, press on the two halves of the rollers and make contact with one or other half as they drop through the perforations in the paper slip when the latter is moved over the roller.

At the receiving end of the line a chemically prepared paper (as in the Bain system) passes under two metallic styles which press on the roller, W; one style being connected to line and the other to earth, as shown in fig. 3. According, therefore, as a positive or a negative current flows to line a mark is made on the upper surface of the paper by one style or the other.

Let us now suppose the slip represented by fig. 1 is turned round and passed from left to right over the roller, W, and under the brushes, b, b^1, then the brush, b, first drops through the first perforation and sends a short zinc current, which represents the first dot of the letter A. The brush, b^1, next drops through the first of the two perforations on the upper edge of the slip, fig. 1, and sends a short copper current to line, which is immediately followed by a second short copper current from the brush, b^1, making contact through the second per-

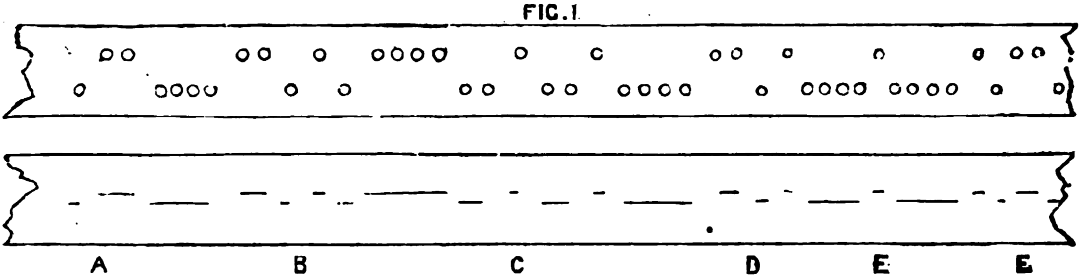
foration; two dots close together are thus formed, but the condenser, C (fig. 3), being charged by the current, discharges itself when the brush is passing over the small interval between the two dots, and this discharge current at the receiving end practically turns the two dots into a dash.

Inasmuch as the dash is not formed by a current left on for a lengthened period, but by two successive currents filled up between, as it were, the condition of the line when the brush leaves the second perforation is the same as it would be if the brush had only passed over a single perforation; thus, after a dash has been formed the line is perfectly clear to receive another signal. After the letter has been completed a dash formed by four per-

reversals of the currents would always take place correctly, but inasmuch as some letters are formed by an even number of signals and some by an odd number, it would be necessary that the perforations representing these letters be reversed continually. The mechanism by which this end is effected is highly ingenious and effectual, though complicated. The perforations are made and arranged by means of mechanism actuated by a key-board similar to that of a Hughes type printer.

Although the system has not been entirely successful in this country, in America it has been worked to a speed of 1,500 words a minute, but this has been obtained with a circuit on an independent line of poles, and with a wire of a large gauge.

FIG. 1.



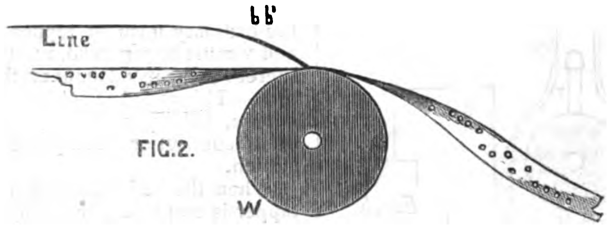
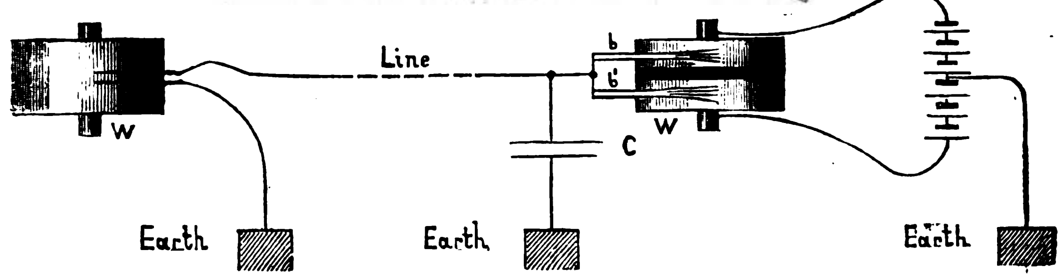


FIG. 2.

FIG. 3.



forations close together is produced, which spaces the letter from the succeeding letter.

Now, supposing that it were required to signal two letter A's one after the other, then if we look at the left-hand end of the perforated slip, fig. 1, we can see that if the relative positions of the dot and dash perforations were the same in both cases two distinct signals would have to be formed by similar currents immediately following one another, thus we should have two A's formed as follows:— . · · . . . . . · · If, however, we wish positive and negative currents to succeed one another alternately, we should require to have the perforations arranged as follows, . · · . . . . · . . ; in other words, we require to have the position of the perforations representing the second letter A reversed. Now, if all the letters were formed by an *odd* number of signals the

The Wheatstone apparatus in England, up to the present, has by no means been worked up to its greatest possible capacity; in fact, no attempts have been made to obtain a greater speed than 250 words a minute. With greater driving power and lighter moving parts a greatly increased speed is undoubtedly possible. The great advantage of the Wheatstone apparatus lies in the fact that in the transmitter, signals cannot be missed—that is to say, the perforated slip cannot move forward to cause a second contact until the mechanical action causing the first contact to be made has acted properly. Where a brush is used to make contacts there is a tendency for the former to jump across from one side of a perforation to the other, instead of dropping down between and making a firm contact.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XXII.

THE UNIVERSAL BATTERY SYSTEM—(*continued*).

THE DROP HANDLE SINGLE NEEDLE INSTRUMENT.

ALTHOUGH Drop Handle Single Needle Instruments are never grouped on a universal battery in the Postal Telegraphic Service, since the number in use is very small, yet it is possible to arrange them so that they may be worked on the universal system.

Unlike other instruments the drop handle instrument to be arranged for universal working requires considerable structural alteration.

Fig. 83 shows the general principle of the commutator as altered for the purpose; the connections being for a "Down" station.

The two contact blocks, g, h, which in the ordinary instrument are connected to, and form part of, the springs, s_1, s_2, are severed from the latter and connected to the battery terminals.

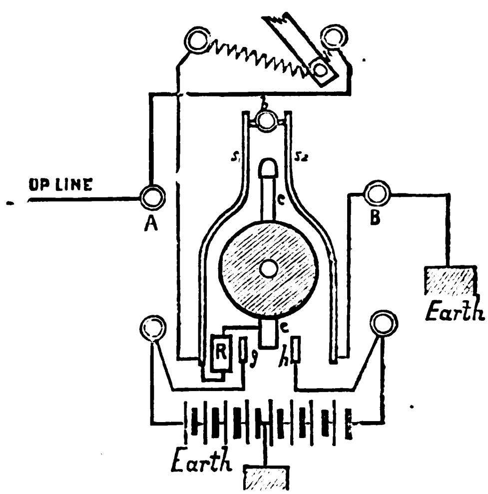


FIG. 83.

Spring s_2 is connected to earth, and spring s_1 to line through the dial, as in the ordinary instrument.

Spring s_1 is also connected through a balancing resistance, R, to the lower brass rod, e; if no balancing resistance is required, s_1 and e are connected direct.

The upper brass rod, c, is left free, no connection being made on to it.

The Copper pole of the battery is connected to g, and the Zinc pole to h.

Action of the Commutator.

The action of the apparatus is as follows:—

Supposing the cylinder to have a right-handed angular movement given to it by means of the handle, then the rod, c, presses against the spring, s_2, and moves the end of the latter away from the bridge, b; the Earth connected to terminal, B, is thus disconnected. On moving the cylinder still further round, the rod, e, touches the block, g, and thus the Copper pole of the battery becomes connected through the resistance, R, and the dial, to the line at terminal, A, and the middle of the battery being to earth, the left-hand half of the former sends a Copper current to line.

If the cylinder be turned in the opposite direction then earth is first taken off by the spring, s_1, being moved away from the bridge, b; and then the rod, c, comes in contact with the block, h, and puts the Zinc of the battery to line, and thus, since the middle of the whole battery is to earth, the right-hand half sends a Zinc current to line.

When the instrument is in its normal position, as shown by fig. 83, then the current of the line is complete through the dial, through spring s_1, through the bridge, b, and thence through spring s_2 to terminal B and earth.

The connections shown, as has been pointed out, are those for a "Down" station. At an "Up" station the battery and coil connections must be reversed.

Drop handle instruments cannot be arranged for working "Intermediate" stations without considerable further structural alteration beyond that already indicated.

BELL CIRCUITS.

The alterations to either form of tapper in these instruments are similar to those made in the single needle apparatus, and the relative connections are the same, except that in the bell instrument with the ordinary form of tapper the strap connecting X and Y must be removed, and the bell relay connected thereto in the usual manner, the line being connected to A. This is for an "Up" station. At a "Down" station, battery and relay must be reversed, the other connections being the same as for an "Up" station.

When the bell instrument with the bell form of tapper is employed, the relay is connected between A_1 and earth in the usual manner. The other connections are the same as for the single needle apparatus.

At "Intermediate" stations the course to be followed is the same as in the case of single needle apparatus.

DOUBLE CURRENT CIRCUITS.

Either "Up," "Down," or "Intermediate" stations on double current circuits can be grouped on one set of batteries.

The connections for an "Up" station instrument are shown by fig. 84. They are the same as for ordinary working, except that terminal 7 instead of being put to earth is disconnected.

At a "Down" station the line connection is the same as at an "Up" station, but the relay and battery connections are reversed.

The equalising resistances in either case are placed in the battery leads as shown.

The total number of cells required for terminal double current circuits worked from a universal battery is double that required for the circuit of highest resistance on the group previous to its conversion.

The connections for "Intermediate" instruments are shown by fig. 85.

The resistance, R, between terminal U or 6 of the relay, and terminal 7 of the key is required in cases

where the "Up" line is shorter, or, rather, less in resistance, than the "Down" line; its value should be such as to equalise the two.

As intermediate and terminal instruments can be grouped on the same battery, it must be recollected in calculating the values of the equalising resistances for the former that the resistance through which each half of the battery has to work is only half that of the entire line. Thus, for example, if a terminal instrument be worked on a line of 1,000 ohms resistance, this being the highest resistance of the group, then if an intermediate instrument be worked with the same group, and the resistances of the "Down" line and balanced (if necessary) "Up" line be each 700 ohms, then the levelling resistances in the battery leads would have to be 50 ohms; for 700 + 50 = 750, which is 25 per cent. less than 1,000 ohms, the resistance of the longest line.

The total number of cells required in the split battery for "Intermediate" instruments, when the "Up" and "Down" lines do not require to be equalised by a resistance, is the same as that required for ordinary working, since each half of the battery works one-half of the entire circuit. When, however, an equalising resistance is required, a proportionately increased power will be necessary. Thus, for example, suppose the "Down" line had a resistance of 1,000 ohms, and the "Up" line a resistance of 500 ohms, and suppose the battery required for working the circuit on the ordinary system was 50 cells, then we have to balance up the "Up" line by putting a resistance of 250 ohms between terminal U or 6 of the relay and terminal 7 of the key, so as to bring the resistance of the "Up" line to within 25 per cent. of the resistance of the "Down" line. Now originally the 50 cells had to work through a

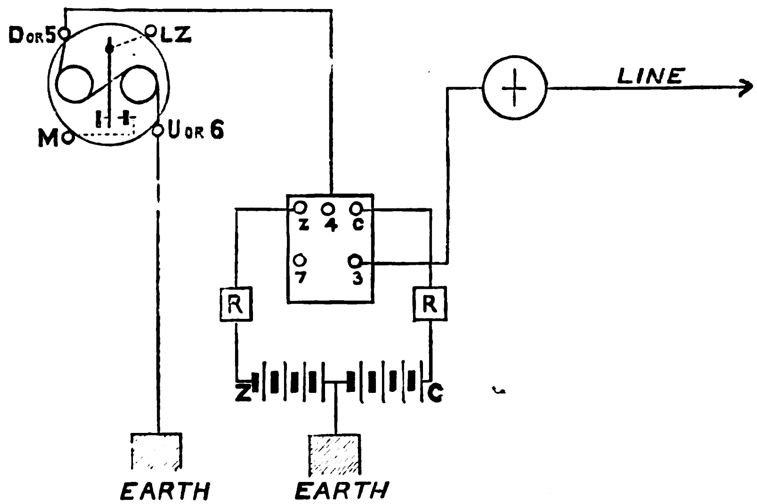


FIG. 84.

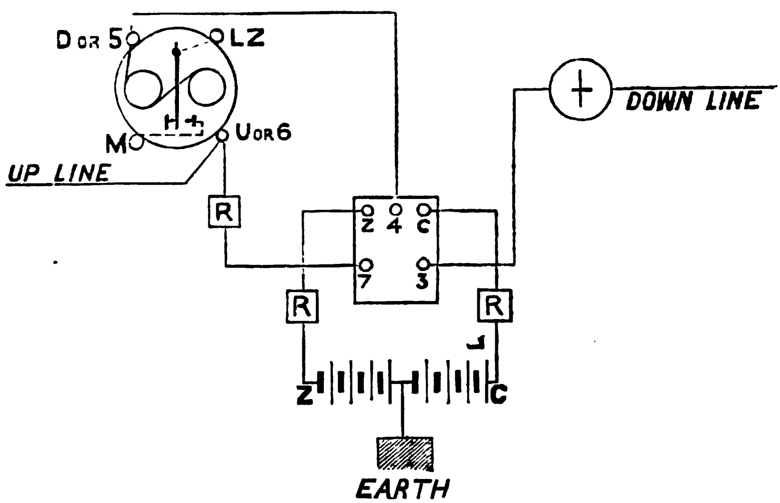


FIG. 85.

total resistance of 1,500 ohms, but now, practically, we may say, the actual resistance to be worked will be 1,750 ohms. Therefore, the number of cells will have to be increased in the proportion of 1,750 to 1,500, that is to say, we should require $50 \times 1{,}750 \div 1{,}500 = 58{\cdot}3$, or say 60 cells. To work properly, therefore, the instrument should be grouped on a 60 cell universal battery.

It will be noticed that the equalising resistance is only in circuit when the station is *sending*, and therefore, the *received* signals are not weakened.

When the "Up" line is longer than the "Down" line, the "Up" line must be connected to terminal 3 of the key; the battery connections must be reversed; terminal 4 of key must be connected to terminal U or 6 of relay; the equalising resistance must be placed between terminal 7 of key and terminal D or 5 of the relay; and the "Down" line must be connected to terminal D or 5 of the relay. The battery power is the same as that stated in the preceding paragraph.

ERRATA.—Article XXI., page 388; bottom line, left-hand column, read "right" for "left"; 3rd line, right-hand column, read "left" for "right"; 22nd line, right-hand column, read "right" for "left."

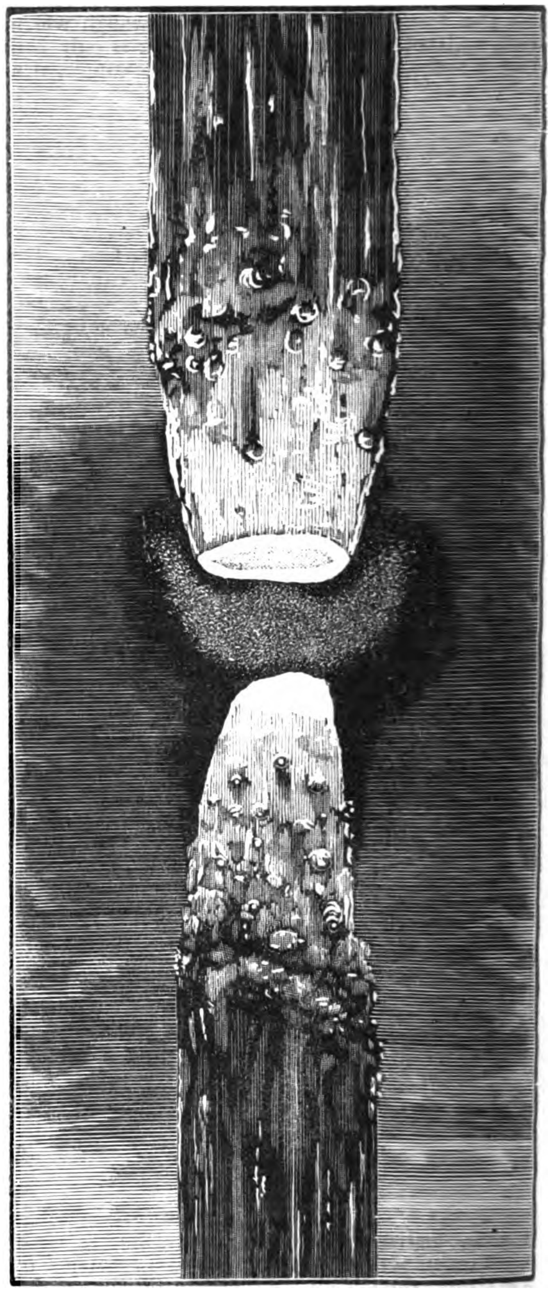
Notes.

WITH reference to Mr. Swan's paper on his new electric lamp, read before the Society of Telegraph Engineers, we give the following extract from the patent, which may throw some light upon the nature of the remarkable material employed for producing the illumination:—"I have found that when the carbon employed within the lamp is an arch or horseshoe-shaped plate, produced by cutting out the arch or horseshoe-shaped piece from a sheet of cardboard, and afterward carbonising it by heat, that the arch or horseshoe-shaped carbon so produced is liable to become distorted and ultimately to break in consequence of the unequal contraction caused by the unequal heating of the inner and outer portions of the arch during the use of the lamp. This defect I remedy by forming the carbon to be made incandescent of a strip of cardboard or paper bent into the form of a hoop or loop; the front view of such hoop or loop showing the section or thickness of the strip, and the side view its width. *The strip of cardboard or paper bent as aforesaid I subject to a white heat in a closed vessel containing powdered carbon or other suitable air-excluding powder.*"

THERE are now 318 telephone exchanges organised and in operation in the United States.

POLICE TELEPHONES.—Chicago leads the way in adopting telephones for general police uses. Experimental telephonic stations have been established at various points in one important district, and relays of mounted officers are kept in waiting at a central station. Reliable citizens are furnished with keys to the telephone boxes nearest their residence. To prevent false alarms the keys are numbered, and cannot be withdrawn from the lock until released by a key carried by the policeman on that beat. When anything goes wrong in a district the alarm is sent to the central station, and explanations are given through the telephone. In case of serious disturbance a large bell is sounded, and every officer on post runs to the nearest box to receive orders.—*Scientific American.*

THE BRUSH ELECTRIC LIGHT.—A powerful electric light on the Brush system was recently exhibited at the workshops of the Anglo-American Electric Light Company, in Vine Street, Lambeth. The intensity of the illumination was, from the single lamp, equal to several



thousand candles, and unusually large carbons were employed for the purpose. Through the courtesy of Mr. W. Ladd we are able to illustrate the actual carbons employed in the experiments. The figure represents the electrodes in full size, in the form assumed when traversed by the electric arc.

FIRE CAUSED BY AN ELECTRIC LIGHT WIRE.—Mr. Jas. Harrison, Superintendent Bureau of Surveys, New York Board of Fire Underwriters, writes the following letter to the *Scientific American*:—"I venture to call your attention to an occurrence which took place at No. 4, Maiden-lane very recently. In the office of Messrs. Silcox & Co., No. 4, Maiden-lane, is a telephone communicating with their factory, No. 14, Maiden-lane. One day, either Monday or Tuesday last, some person on the roof of one of the intervening buildings dropped an *electric light* wire upon that of the *telephone* wire of Messrs. Silcox, bringing the two wires in contact. The effect rather astonished the people in the office. Flames burst forth from the telephone instrument on the wall, producing such an intense heat as to entirely destroy the magnets." Although doubt has been expressed as to the accuracy of this statement, such an accident is quite possible.

MR. SPOTTISWOODE, president of the Royal Society, was present at the sitting of the French Academy of Sciences on the 15th inst. He witnessed experiments made at Méritens' workshop on the magneto-electric engines which have been ordered by the Trinity House. The trials were successful.—*Nature*.

ON the night of the 3rd inst. a magnificent display of aurora was seen from various parts of the country. We have received several communications on the subject. Mr. E. W. Prevost writes from Cirencester that the display was visible there from 6 p.m. up to about midnight. "The glow, which extended over an angle of about 100°, rose upwards to a height of 20°, leaving the central portion comparatively dark. Faint streamers occasionally showed themselves, reaching 35° in height. A shifting of the streamers from east to west was noticeable, the illuminated arc being at times extinguished on the eastern side, this extinction progressing slowly towards the centre of the arc, when the light would reappear at the eastern side. At no time, as far as I observed, did the light disappear on the western side; the colour was of a greenish-yellow and the wind due north." From Bootham, York, November 3rd, Mr. J. Edmund Clarke writes:—"There is quite a brilliant aurora this evening, first noticed about 6.30 as a diffused light shifting from north-east to south-west, with occasional streamers. Now (7.30-8.45 p.m.) it forms a low bright arch of considerable intensity. I said 'first seen about 6.30,' but at 4.40 I called the attention of a friend to some sharply-defined red streamers in the north-east, which I then took to be sunlight. On August 12th last, about ½ to ¾ hour after sunset, my attention was called to streamers precisely similar, in every respect like those of the aurora. But careful observation showed that these were certainly radiating *from* the sun, and not converging *towards* the magnetic pole. It is certainly my impression that such was the case to-night, but being busy I did not take any special pains to ascertain. Of course this double coincidence may be a pure accident, but is it not possible that the minute substances reflecting the solar rays are actually modified by the electric field, so as to produce this remarkably distinct variety of rays? P.S.—8 p.m. Brilliant streamers from the bright arch, with some corruscations." Prof. Reilly, of the Royal College of Science for Ireland, writes that in Dublin the display was very fine. "The principal beam appeared as if slowly moving from west to east, and had a direction quite parallel to the pointers of the Great Bear. It reached at the time when seen quite up to the Polar Star. The lights were observed at earlier hours, one person having mentioned to me 6 o'clock p.m."—*Nature*.

MR. C. HUTTMAN, of Vienna, has invented an electrical spur for the management of horses.

ARRANGEMENTS are being made to put the Cape Observatory into connection with that at Aden for astronomical purposes.

AN International Exhibition of Electrical Appliances is to be opened at Paris on the 1st August next, and will remain open until November 15th. M. Georges Berger has been appointed Commissioner-General of the Exhibition and also of the Congress to be held in connection with it.

NEW SUBSTITUTE FOR RUBBER.—This artificial composition, says the *English Mechanic*, which answers the purpose of genuine caoutchouc or gutta-percha, can be employed, according to Dankworth and Sanders, of St. Petersburg, either alone or in connection with other resinous substances. According to *Ackermann's Gewerbezeitung*, this new product affords an inexpensive means for a perfect isolation of wires for electrical purposes. The composition is elastic, tough, not so sensitive to external influences as caoutchouc or gutta-percha, and is not injured by high pressure or high temperature. It is prepared in the following manner:—A quantity of coal-tar oil, or equal parts of coal and wood-tar oil, which is to constitute a third part of the whole mixture, is poured into a large kettle, together with an equal quantity of hemp-oil, and is heated for several hours, either over steam or an open fire, to a temperature which lies between 252° and 288° Fah. (it should not exceed the latter), until the mass becomes so ductile that it can be drawn in long threads, and the remaining third, consisting of a quantity of linseed oil, which has been thickened by boiling, is then added. With this composition from 5 to 10 per cent. of ozokerite and some spermaceti should be mixed. The mass is then heated again for some hours at the same temperature as above, and finally from 7 to 12 per cent. of sulphur are added. The mixture thus obtained is cast into forms and treated the same as caoutchouc. The proportion of the three oils may be slightly varied according to the practical purposes for which the composition is to be used.

A NEW MILITARY TELEGRAPH LINE.—The Signal Service, U.S.A., has just completed a transcontinental military telegraph line from Bismarck, Dacotah, to Dayton, Washington Territory. It crosses the rocky mountains by the Sohm Pass over the Mullan Road.

AN electric railway between Lichterfelde and Tettow, with a branch line to Grosse Kadettenhaus, is now being constructed by Messrs. Siemens and Halske of Berlin.

EDISON'S original lamp, with the carbon loop, is now in the South Kensington Museum (the Patent Museum). It is accompanied by a certificate from Mr. Edison stating that it burned for 1,390 hours.

SWAN'S electric lamps have been fitted up by Mr. Stearn, of Rock Ferry, Liverpool, in his residence.

REYNIER'S BATTERY.—The solutions which it is best to employ in this battery are, according to the patent specification, No. 1234, as follows:—Water, 1,200 parts by weight; soda, 300; potash, 100; chlorate of potash, 20; chlorate of soda, 20; chloride of potassium, 20; chloride of sodium, 20; sulphate of potash, 20; sulphate of soda, 20; the zinc plate is immersed in this solution. The depolarising liquid in which the copper plate is immersed should be as follows:—Water, 1,200 parts by weight; sulphate of copper, 240; nitrate of copper, 60; chlorate of potash, 20; chlorate of soda, 20; chloride of potassium, 20; chloride of sodium, 20; chloride of zinc (saturated solution), 20;

sulphate of potash, 20; sulphate of soda, 20; sulphate of zinc, 20.

EXPERIMENTS by Forbes in 1831, and by some others since, seemed to warrant the view, now commonly held, that the metals fall into the same series as regards conduction of electricity and conduction of heat, that the quotient of the heat conductivity by electric conductivity is nearly constant. Herr H. F. Weber, inclined to doubt this as contradicting the view (proved for gases and liquids) that the amount of heat transferred within a substance from layer to layer is most intimately connected with the specific heat of unit volume, made new experiments in this relation (which he has described to the Berlin Academy). He measured the heat-conduction by observing the cooling of various metal rings in a space at constant temperature, and the electric conducting power of the same rings by noting their deadening effect on the oscillations of a magnet. The result confirmed his anticipations, the quotient of heat-conduction by electric conduction being found in the closest connection with the specific heat of unit volume. Experiments by a different electrical method for metals conducting electricity badly (lead, bismuth, &c.), and for mercury gave the same result. (Ten metals in all were examined.) On the other hand, non-metallic conductors of electricity do not show the relation in question, *e.g.*, the heat-conduction of carbon is at least twenty to thirty times greater than that calculated from the electric conductivity and the specific heat. Thus the relation seems to be connected with the metallic nature of the substance. Herr Weber found the heat-conducting power of all the solid metals examined to decrease with increasing temperature, but at a considerably less rate than the electric conductivity. He further offers explanations of the erroneous view adopted, noting, *inter alia*, that the experiments in one case, though exact, were on too few metals, and these had nearly the same specific heat.—*Nature.*

PERRY AND AYRTON'S DISPERSION PHOTOMETER.—This instrument, which is peculiarly adapted for comparing powerful lights with the standard candle, is now manufactured and sold by Messrs. Latimer, Clark, Muirhead and Co. The principle of construction is that of weakening the light to be measured by illuminating a screen at a great distance from the source; the same effect is produced by passing the light through a lens. It is evident that with the use of a lens a space of only a few feet will suffice for the measurement of a powerful electric light.

IN a letter to the *Operator*, Mr. T. D. Lockwood discusses the right of Mr. Berliner to the credit for having been the first to invent an instrument identical in principle with the microphone of Professor Hughes. He says that on April 14th, 1877, Mr. Berliner filed a caveat in the patent office at Washington, describing the contact telephone, or microphone. On April 27th, 1877, Mr. Edison filed an application in the patent office on his battery transmitter. On June 4th, 1877, Mr. Berliner filed his application in the patent office for a patent on the same invention previously described in his caveat of April 14th, 1877. In December, 1877, Mr. Hughes commenced his experiments; privately exhibited his microphone in January, 1878; and gave his perfected invention to the public in May, 1878.

THE subjoined Fleet circular has been issued by the Admiralty:—"My Lords Commissioners of the Admiralty are pleased to direct that in future the captains and commanding officers of Her Majesty's ships and vessels are to be held responsible for ascertaining that the continuity of the lightning-conductors on board the ships and vessels under their command is complete, and also for maintaining such lightning-conductors in a state of efficiency. In ships which have galvanometers on board the conductors are to be tested periodically, and in ships which are not supplied with such instruments the commanding officer is to apply for the conductors to be tested, when an opportunity offers, at a dockyard."

MR. HARRY S. FOSTER (of the firm of Foster, Hight, and Co., Copthall Buildings) has been appointed liquidator of the Electric Carbon Company, Limited.

THE PHOTOPHONE.—Professor Graham Bell has promised to read a paper before the Society of Arts upon his "Photophone" at the ordinary meeting on Wednesday, December 1st. As considerable interest is likely to attach to this paper, it is announced that only members of the Society can be admitted, and that they will be required to provide themselves with special tickets issued for the occasion.

M. JANSSEN has placed all the instruments in the observatory at Meudon, near Paris, at the disposal of Professor Bell, for the purpose of determining if the photophone is applicable to a study of the sounds which are supposed to occur on the surface of the sun.

MR. JOHN TROWBRIDGE, of Harvard University, Cambridge, Mass., has published some very interesting results respecting the behaviour of the earth's surface as a conductor of electricity, and its capacity for transmitting electric signals without the aid of a conducting wire. The experiments were made between Boston and Cambridge. It is stated that, on completing the circuit through a telephone and the ground, the existence of an electric current was plainly apparent from the ticking which the making and breaking of the circuit produced in the telephone, and that the time signals of the observatory clock were distinctly heard. Mr. Trowbridge concludes that theoretically it is possible without a cable to telegraph across the Atlantic Ocean. Apropos of these experiments, we may remark that a patent (No. 1909) was taken out in 1853 by G. E. Dering, for a method of telegraphing across water without wires, and a mode of uniting Great Britain and America by means of wires from the Land's End to the Giant's Causeway and Longerside in America. A patent (No. 1242) for effecting a similar object was taken out in 1854 by Mr. J. B. Lindsay.

MR. VAN CHOATE's idea of relaying the Atlantic Cables, by means of a relay in mid-ocean, was anticipated by a patent (No. 156) taken out by four *ladies* in the year 1865.

AT the last meeting of the Edinburgh Town Council notice of motion was given, that it be remitted to the Lord Provost's Committee, with powers to order the removal of such telephone wires throughout the city as endanger or inconvenience the public, and to take such steps to prevent the future erection of such wires without authority.

THE large and commodious premises which have been for a considerable time in the course of erection for the Edinburgh Stock Exchange are rapidly approaching completion, and it is expected will be occupied before Christmas. The present Exchange is in direct telegraphic communication with the London and Glasgow Stock Exchanges, and with the Edinburgh General Post Office. Owing, however, to the great amount of business which is now transacted these arrangements are inadequate, and strenuous efforts are

being made to obtain an additional London wire, and for the establishment of direct communication with the Liverpool and Manchester Exchanges.

WE hear that Mr. Brockie has slightly modified the clutch of his lamp as described in our issue, No. 172, p. 114. We had the pleasure of seeing the modified form in use the other evening, and were much gratified at its behaviour. This lamp is admirably adapted by its simplicity for lighting large spaces, as the service of an attendant for regulating it, when once adjusted, is entirely unnecessary.

Correspondence.

THE TELEPHONE.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—While working with a Gower-Bell telephone and a Crossley transmitter and Bell receiver in circuit it was observed that when speaking on the "Gower" the sounds always proceeded from the Bell receiver, and when speaking on the Crossley transmitter from the "Gower" with very marked improvement in distinctness.

Moving the Bell receiver when speaking on the Gower, or the Gower when speaking on the Crossley, gradually from the ear, when a distance of three-quarters of an inch intervened the sound began to move round to the other telephone, and when the distance was increased to an inch and a half the sound passed entirely into the other telephone.

On connecting an astatic galvanometer, the best at hand, in circuit with the Gower, and blowing with sufficient force to produce a clear sound on the whistle, the needle was deflected through 40 divisions. Increasing the blowing force until a deep sound was produced, the needle returned to zero, and passed through 10 divisions in the opposite direction.

The effects obtained when the blowing was at the distant station were similar but less marked, the deflections being 15 and 5 divisions respectively.

The figures given are the averages of several trials.

I am, Sir,
Yours faithfully,
Edinburgh. F. MACRAE KEITH.

MAGNETIC STORM.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—The "magnetic storm" in connection with the display of aurora borealis of September 12th, mentioned in your issue of the 1st ult., was felt in full force in this part of South America.

The earth currents observed on the Rio Grande do Sul, Monte Video section of the Western and Brazilian Company's cables, were the strongest I remember ever having seen. The rapidity with which they changed direction, from positive to negative, and *vice versâ*, was simply astounding, and prevented measurements being taken.

Traffic was entirely suspended from 9.0 a.m. to 1.35 p.m., Rio de Janeiro time, and during the remainder of the day we experienced the greatest difficulty in working. The following quotations are from the Monte Video and Rio Grande diaries.

From Monte Video Diary.

"August 12th, 1880. 9.0 a.m. to 1.30 p.m. Unable to work. Earth currents too strong. 1.35 to 9.0 p.m. Earth currents greatly moderated, but still powerful, and working with greatest difficulty."

From Rio Grande Diary.

"August 12th, 1880. 9.5 till 1.35. Unable to keep spot on scale. Earth currents. Been trying to work to Monte Video, but impossible to keep light on scale. He says something about earth currents, and is unable to read."

I inclose you three cuttings from our slip, these being the only marks we managed to get on the tape for some three or four hours, owing to the coil being jammed first in one direction and then the other, more rapidly than we could adjust for.

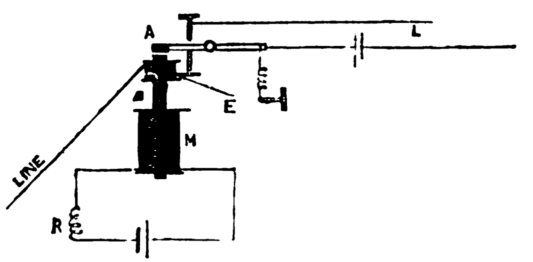
I understand the River Plate Company also experienced great difficulty in working between Monte Video and Buenos Ayres (Morse circuit), during the greater portion of the day, owing to very powerful "deflections."

I am, Sir,
Yours faithfully,
Monte Video, W. F. NOSWORTHY.
October 18th, 1880.

VYLE'S RELAY.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In your last issue, November 15th, a description is given of a new form of relay, invented by Mr. C. C. Vyle, of the Postal Telegraph Department, the idea conveyed being that this form is quite original. Will you allow me to point out that this is scarcely correct, as two years ago I constructed a relay on the same



A. Soft iron. R. Resistance in current of electro-magnet, M. L. Local circuit.

principle, and worked it on two circuits of 300 and 500 miles respectively, where, for a roughly-made apparatus, it worked exceedingly well, both single and double current. I may mention that the receiving coil was a small one of not more than 50 ohms resistance, showing the extreme sensitiveness of this system. I beg to attach sectional view of the relay, the only distinction between this and Mr. Vyle's being the substitution of electro for permanent magnet.

I am, Sir,
Yours truly,
22, Athelstane Road, W. BOLTON.
N. Bow, E.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In reference to your article on "A New Relay," page 378, vol. viii., it may not be uninteresting to your readers to know that a direct double current sounder on this principle was introduced here by the chief mechanic and myself in 1873, and placed on trial for some weeks on several important circuits, giving good results.

The idea was suggested by observing the effect of contact on the Hughes instrument by

Yours respectfully,

Postal Telegraphs, FRED. T. BROWN.
Birmingham, Nov. 27, 1880.

E. PAGE.—The inducing magnets of a Siemens machine are usually wound with about No. 12 wire, and the induced magnets with about No. 14; but these sizes vary according to the work the machine is required to do. The Gramme is wound with similar wire. We are unable to say what wire is employed on the Wallace-Farmer electric light machines and the Weston plating machine, but perhaps one of our correspondents can inform you. The wires are merely insulated with cotton.

Proceedings of Societies.

THE PHYSICAL SOCIETY.—Nov. 13, 1880.

MR. BOSANQUET, of St. John's College Physical Laboratory, Cambridge, read a paper on "The Nature of the Sounds which Occur in the Beats of Consonance." From sustained octaves and twelfths he found that, when the beats of the harmonies are cleared away, each beat consists entirely of variations in the intensity of the lower notes. He gave the mathematical theory of these beats, and likewise of the curves given by the harmonograph. He also described an ear tube for using in connection with a resonator. It is difficult to get definite results with a resonator unless the passage from the latter to the ear is closed to sound. The ear tube consists of a copper pipe bent into a sickle shape to gird the face, so that the ends may enter the ears, into which they are screwed, plugging them close. The sound is led from the resonator to the middle of this bent pipe by a flexible india-rubber tube, and thence to the ears.

Mr. BROWN read a paper on "Action at a distance." He drew attention to the fact that though Newton disbelieved in action at a distance he did not pronounce whether the medium was material or immaterial. Mr. Brown showed that the hypothesis of a material medium was encumbered with difficulties, since, among other reasons, direct contact could not explain gravity; projection of small particles from one body to another could not explain attraction; and Le Sage's theory of corpuscles (as modified by Mr. Solver Preston) required an enormous degree of porosity in masses of matter. The nature of magnetism and vibration was also discussed by the author.

Mr. J. MACFARLANE GRAY read a paper on "The Mechanical Nature of the Forces called Attractions," and gave grounds for attributing them to the pressure of a universal material ether of a gaseous nature.

Profs. W. E. AYRTON and J. PERRY read a paper on "A Note on Exner's Papers on Contact Electricity." Assuming that the heat of combustion, due to the chemical actions going on in a cell, represents the E.M.F., Exner states that the difference of potential between zinc and its oxide, which he calls 2 E, is measured by the heat due to oxidation of zinc. If a non-oxidisable metal, say platinum, is brought into metallic connection with the zinc, the platinum takes art of the charge of the zinc, and the difference of potential between the platinum and the oxide of zinc becomes E. And from this it follows that the difference of potential between two metals in contact in air is measured by half the difference of their heats of combustion in oxygen. To show that his reasoning is correct, Exner has made experiments on three contact differences of potential, which agree very remarkably with the theory. But if the statement agrees with experiment, Messrs. Ayrton and Perry showed that it might be regarded as a most important empirical law; but experiments of Kohlrausch, Hankel, and the authors show that the empirical law does not hold. The authors then take up Exner's crucial experiment, to show that two plates of silver, one in an atmosphere of chlorine and the other in an atmosphere of oxygen, but in metallic connection with one another, show a difference of potential. They point out that if this experiment had been properly performed it would have corroborated the result arrived at by Mr. Brown of Belfast, which in no way contradicts the contact theory.

The authors point out that Exner's statement as to what the contact theory requires in a Smee cell is quite gratuitous, and indicates that he is not at all acquainted with the contact theory.

The authors incidentally referred to the complete disproof of the results of Exner's experiment on thermo-electricity given lately by Professor Young, of Princeton.

Professor MINCHIN, of Cooper's Hill Engineering College, exhibited a new "Photo-electric cell." This consists of a vessel of water containing a little acid, carbonate of calcium and two tinfoil plates. When a beam of lime light was allowed to fall on one of the plates a powerful current was set up in the cell, as seen by the deflection of a galvanometer connected in circuit with the plates. When a red glass screen intercepted the beam the effect was very slight. Professor Minchin had begun his experiments with fluorescence, but found "hard" water containing this salt of lime does equally well. The cell possesses this advantage, that the current it gives soon decreases in the light. When first the light falls on it the exposed plate is positive, but it soon changes to negative. Professor Minchin had tried the cell in place of a selenium one in the photophone, but with unsatisfactory results.

THE SOCIETY OF TELEGRAPH ENGINEERS.

AN ordinary general meeting of this Society was held on Wednesday, Nov. 24th, Mr. W. H. PREECE, president, in the chair. The minutes of the last general meeting having been read and confirmed, the President announced that at a meeting of the Ronald trustees it was unanimously agreed that the Society of Telegraph Engineers had fulfilled the conditions upon which the Ronald's library was to be held by the Society. On the 22nd a general meeting would be held on which regulations for opening the library to the public would be considered.

Mr. J. W. SWAN then read a paper on "A system of sub-dividing the Electric Light."

Mr. SWAN first referred to arc lighting and lighting by the heating of carbon rods by the passage of the current, and stated that theoretically a light produced by the latter system was above all others very good. The electric light is unquestionably economical when concentrated, but possesses great mechanical defects. The arc light is not of much use for small lights, not being economical.

Several systems of lighting by incandescence have been stated to have been successful, but such has not really been the case. Definite numerical data are wanting on the subject, since mere impressions are not sufficient to guide any one.

Arc lights have never been properly measured. The Glasgow competition, which is the only case where

trustworthy measurements have been made, did not have a sufficient number of competitors to be of much value. Crompton's lamp, however, was thoroughly tested there.

The arc light, Mr. Swan repeated, is not economical except in special cases, as, for example, the Albert Hall, the British Museum, and St. Enoch's Station, Glasgow, where a few large lights are used only.

When a large number of lights are used, the consumption of a large number of carbons, and the loss of light by the sub-division, makes a very material difference; this is particularly noticeable on the Thames Embankment.

In estimating the light given by one or more lamps, the light obtained at every part of the space illuminated must be considered. A disadvantage of employing large lights is that when one is close up to it it gives too much light, and when far off too little. Mr. Swan considered that the arc light system would have to be abandoned, as it could not be sub-divided without loss.

The principle of incandescence is the only economical one, as by it subdivision can be effected without loss; this is proved by Faraday's laws, as a definite amount of current will produce the same amount of heat in one inch as in a hundred inches of wire. Theory, therefore, is in favour of incandescence.

Many materials have been tried for incandescent lamps, viz., platinum, iridium, and carbon. The metals, however, fuse at a high temperature. Mr. Swan then alluded to Edison's experiments with platinum wire.

Carbon was used in an incandescent lamp by King in 1845. In Werdermann's, Reynier, and André's lamps the consumption of the carbon does not affect the system, and they cannot, therefore, be said to be incandescent lamps exactly.

If it is required to prevent the combustion of the carbon, the latter must be placed in vessels exhausted of air, or else filled with nitrogen or other similar gas. The Sawyer-Mann lamp is of this description. Mr. Swan stated that in all his experiments he had dealt exclusively with a vacuum. This method would seem more difficult than the former, but certain difficulties cropped up when an incombustible gas had to be dealt with which did not occur in the case of a vacuum. Thus attrition of the carbon took place from the action of the particles of gas moving about.

Three causes existed which made incandescent lamps failures—1st, the carbon being too thick; 2nd, the carbon not being durable; 3rd, the obscuration of the glass globe in which the carbon was placed from a deposition of carbon particles on the side.

Mr. Swan held the opinion that the incandescent light was the light of the future.

Carbonised paper was tried by Mr. Swan 20 years ago, the first experiments being made with a 10-cell Callan battery and a *ringlet* of carbon, but no effect could be obtained. A horse-shoe of carbonised paper one inch high and one inch broad was subsequently tried, and with 50 Callan cells a bright red heat was obtained. Having no greater battery power at his disposal, Mr. Swan was unable to carry his experiments further.

The introduction of dynamo-electric machines and of the Sprengel air-pump enabled Mr. Swan to pursue his experiments with more success, and in these experiments great assistance was given by Mr. Stearn, of Birkenhead, who was skilled in the use of the Sprengel air-pump.

The disintegration of the carbon was the chief difficulty to be got over. Although tolerably good results were obtained with carbonised paper, a new material was at length found which gave much better results. This material was steel-like in its elasticity, and for Mr. Swan's purpose was in the form of wire $\frac{1}{100}$ of an inch thick. The hardness of the material was found to increase by use.

In the experiments the light was obtained by a current of about one weber, the resistance of the carbon filament being when cold about 150 ohms. The best current to be employed had not been yet ascertained, but one weber would give about 60 candle-power, the electro-motive force of the current being about 100 volts. Sixteen lamps were tried in Sir William Armstrong's residence with full power, and a magnificent light was obtained. It was not safe, however, to heat the carbon too much, as its durability would probably be impaired. If the light given by each lamp does not exceed 30 candles, there is no doubt but that the lamps will last for several months at least, and it is probable that even 60 candle-power could be obtained without damage.

Although for short distances the lamps might be joined up in multiple arc, for long distances they would require to be joined up in series. There would be no difficulty in varying the current according to the number of lamps joined in the circuit.

With regard to the supersession of gas light by the electric light, the question of durability of the lamps had yet to be determined; but even if the electric light became a complete success, Mr. Swan did not think that gas would suffer even if it did not gain. In concluding, Mr. Swan expressed his thanks to Mr. Ward of the British Electric Light Company for the assistance given in providing the current for working the lamps.

In the discussion which followed the reading of Mr. Swan's paper—

Mr. CROMPTON stated that in his experience small arc lights are less economical than gas, but that large arc lights are more economical. He drew attention to a curious fact in Mr. Swan's lamps, viz., that by reducing the length of the carbon filament from 1½ to ¾ of an inch the light was increased five-fold. Mr. Crompton considered that the public would not be satisfied unless for a definite amount of money a very considerable increase of light was obtained by the electric over the gas light if the latter was to be superseded. Arc lights he did not think would come into collision with incandescent lights, as each had their special uses.

Dr. HOPKINSON said that small arc lights were not necessarily wanting in economy if 3 millimetre carbons were used; but small lights should be produced by direct and not alternating currents.

Mr. A. SIEMENS considered that large arc lights were necessary in illuminating large spaces, and that small lights did not give good effect. He did not consider that gas would be dispensed with, as it would always have a use for other purposes than lighting.

Mr. BERLY thought that small lights would come into extensive use. There was no reason why gas light should not be concentrated in lighting large spaces.

Professor TYNDALL congratulated Mr. Swan upon the success he had obtained. He considered the problem of lighting by incandescence as almost completely solved. The light might, he thought, be adopted with great advantage in coal mines.

Mr. SHOOLBRED pointed out that the arc lights gave a power of 550 candles per horse-power, and he doubted whether Mr. Swan obtained nearly that value with his system.

Professor AYRTON calculated that a current of 1 weber and a resistance of 150 ohms in each lamp represented an amount of energy expended equal to twenty times that required in an arc lamp for the same amount of light, and, therefore, if Mr. Swan's lamp is twice as

economical as gas, how much more economical is the arc light.

Mr. MOULTON inquired whether the adjustments, &c., of Mr. Swan's lamp were beyond the attainment of domestic servants, and he pointed out that this question had an important bearing upon its general adoption.

Mr. C. F. VARLEY pointed out that the resistance of the lamp (150 ohms) was the resistance of the cold carbon, and that when the latter was heated the resistance would change very considerably. He suggested that the vapour of an undecomposable metal might be tried in the lamp. The value of the light compared with the standard candle was, he pointed out, fallacious as usually estimated as the question of colour came into play.

Mr. SWAN, in reply to the queries, stated that as regards durability he had had a lamp burning continuously since August 8th, except for an interval of three weeks. His carbon patents would shortly be published, and the secret of the method of preparation would then become public. He showed that his lamps could be replaced with the greatest ease if required. He did not pretend that his system was the most economical possible, though it was cheaper than gas; he could obtain 150 candles per horse-power, which he contended was a good result. With regard to the use of the lamp in coal mines, he thought that the time was not ripe at present for the experiment.

A vote of thanks to Mr. Swan having been proposed by Sir CHARLES BRIGHT, and seconded by Mr. LATIMER CLARK, was carried unanimously. A vote of thanks was also passed to the British Electric Light Company for their disinterested assistance. The meeting then adjourned.

New Patents—1880.

4608. "Improvements in the means and apparatus for generating, sub-dividing, and transmitting electric currents, also in electric lamps." C. F. HEINRICHS. Dated November 9.

4614. "Electric lamps." C. W. SIEMENS. Dated November 10.

4621. "Magneto-electric signal apparatus." E. G. BREWER. (Communicated by E. H. Johnson and T. A. Edison.) Dated November 10.

4628. "Step by step type-printing telegraphs." F. H. W. HIGGINS. Dated November 10.

4674. "Telegraph cables." R. KENDAL. Dated November 13.

4739. "Electric batteries." H. E. NEWTON. (Communicated by L. A. W. Desrouelles.) Dated November 17.

4745. "Electric lamps." J. E. H. GORDON. Dated November 17.

4755. "Electric lamps and apparatus connected therewith." J. A. BERLY and D. HULETT. Dated November 18.

4779. "An improved electro-magnetic apparatus for table-services, offices, and warehouses." F. HARMANT. Dated November 19.

4825. "Dynamo-electric motors." C. KESSLER. (Communicated by E. Kuhls.) Dated November 22.

4850. "Improvements on switches and apparatus for use upon telephone lines." S. PITT. (Communicated by C. D. Haskins.) Dated November 23. *Complete.*

4862. "Telephones." S. PITT. (Communicated by C. de Nottbeck.) Dated November 23.

4866. "Electric lighting apparatus (electro-magnet)." W. R. LAKE. (Communicated by H. S. Maxim.) Dated November 23. *Complete.*

4886. "Dynamo-electric machines and lamps for electric lighting." J. HOPKINSON and A. MUIRHEAD. Dated November 24.

4887. "Speaking tubes and electric bells for use with the same, applicable also for other purposes." G. JENNINGS and E. G. BREWER. Dated November 24.

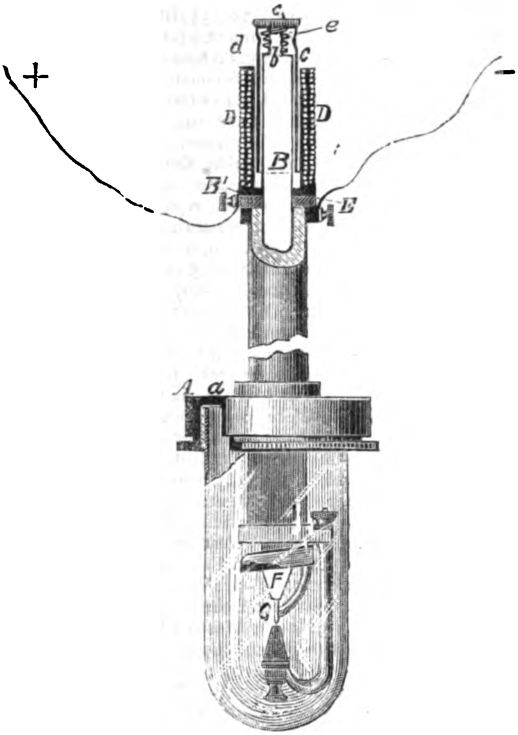
4914. "Electric light apparatus." W. L. WISE. (Communicated by J. A. Mandon.) Dated November 25.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

1385. "Dynamo or magneto-electric machines and electric motors." THOMAS ALVA EDISON. Dated April 5. 6d. Relates to the rotating armatures, the arrangement of the commutator brushes or contacts, and the shaft of the rotating armature and commutator, which are applicable to both dynamo or magneto-electric machines and to electric motors. The armature is constructed of a number of very thin discs or rings secured together upon a proper shaft or base, and slightly insulated from each other. The brushes or springs are set at an angle of about 30° to the axis of the commutator. When a breakage of the circuit is required it is done at several points simultaneously, so that the spark at the rupture is spread over several points, and does not burn up the contacts.

1507. "Electric lamps." G. G. ANDRÉ. Dated April 13. 6d. In electric lamps in which a stick of carbon is made to "burn" in a closed vessel or globe, the atmosphere contained therein, when the light is turned out by the current being cut off, consists of carbonic oxide and nitrogen. Owing to practical difficulties, in the way of making joints, it is generally found that the atmospheric air, while the lamp cools down, slowly enters the globe, and the atmosphere therein then consists of carbonic oxide mixed with oxygen and nitrogen, forming an inflammable mixture which, when the lamp is relit causes an explosion and a destruction of the globe, and sometimes also the interior parts of the lamps. The objects of this invention are to prevent the above evil, to regulate the consumption of the carbon as desired, and, as regards carbon lamps working by incandescence, to preserve the point of the carbon. A small hole, *a*, is provided through the sole or cover plate, A, of the lamp, and the size of this hole is such as to supply the incandescent carbon with a small quantity of air sufficient to preserve its form, and to burn the carbon dust thrown off, or nearly so. This aperture may, if desired, be made adjustable by being increased in size, and fitted with a somewhat conical screw, or one having one or more taper flats, which are broadest at the end filed on it (like a tap for forming screw thread in nuts), or in any other suitable and well known manner. The tube, B, for the carbon and the weight resting thereon is narrowed at the top at *b*. C is an iron cap or tube valve, which is free to slide on the tube, *b*; it has a leather washer, *c*, inside the top, and has one or more holes at *d*; the cap tube, C, forms a solenoid core inside the coil, D, which rests on the flange, B^1, on the tube, B; E is an insulating washer. As long as the current is on, and the lamp burning, the core tube, C, is drawn down, and the leather washer, *c*, then rests on the top of the tube part, *b*, preventing air escape or entry at this place, but as soon as the lamp goes out, the current ceasing,

the least pressure inside the lamp globe or cylinder will raise the cap tube or valve, C, and such pressure will then be relieved, and a current established by the hole, *a*, and the holes, *d*. The possibility of an explosion is



thus prevented; *e* is a helical spring for raising the cap tube, or valve, C, when the electric current ceases.

1510. "Insulators." A. Gilbert, G. Wells. Dated April 13. 4d. The invention has for its

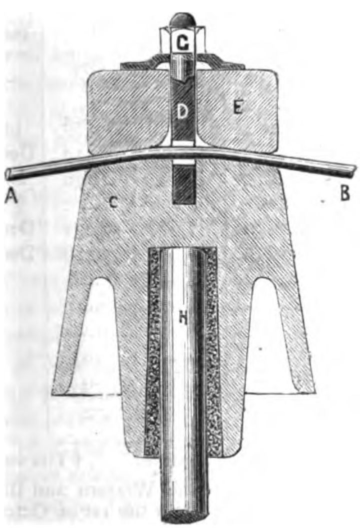


Fig. 1.

object the production of an insulator so constructed as, without affecting the insulation, to secure the wire, so that, in the event of the wire breaking between any two posts, the other parts of the wire on the other sides of the posts between which the breakage occurs shall remain securely held as before. Fig. 1. represents a section taken through the insulator in a line with the wire; fig. 2, a transverse section. The insulator proper is of the ordinary bell shape. The part, C, has embedded in it at the time of making a screw bolt, D, so that when the wire, after being properly strained, is laid in the groove made for its reception in the part, C,

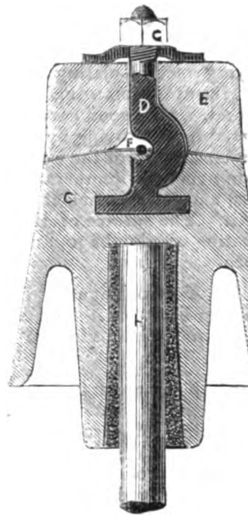


Fig. 2.

the cap, E, of the insulator, which has a corresponding groove, and through the centre of which the bolt, D, passes, is placed thereon, and by means of the nut, G, is brought to bear tightly upon the wire, F, which is thus rigidly held between the grooves in the insulator, C, and cap, E. The bolt, D, is made of the shape as shown in fig. 2, so as to allow of the wire being readily placed in or removed from the insulator, and at the same time to bring the pressure of the nut directly over the centre of the cap.

1511. "Telephone switches." John Henry Johnson. (A communication from abroad by Ernest Marx, Frank A. Klemm, and Julius Kayser, of New York.) Dated April 13. 6d. Relates to certain improvements in the construction of telephone switches. It has for its objects simplicity and economy in construction and absolute positiveness in operation, and, with these ends in view, the invention consists of a stationary hanger-post in combination with a vibratory bell crank lever and flat spring, so arranged in relation to the main line wire bell telephone and transmitter wire and local battery, that the presence of the telephone in position will positively connect the bell with the main line, and open the local circuit, and its removal for use will cut out the bell, close the local battery circuit, and put the telephone and transmitter on the line.

1552. "Electric lamps." Alexander Melville Clarke. (A communication from abroad by Jean Marie Anatole Gérard-Lescuyer, of Paris.) Dated April 15. 6d. Relates to an improved arrangement of electric lamp or burner, which is distinguished from all others now in use by its simplicity, its great lighting

capacity in proportion to the expenditure of power, by the electrodes being automatically maintained at an invariable distance apart, whereby absolute fixity of the light is insured, and also by the length of time during which it will burn without attention. The chief improvement consists in the arrangement of the electrodes, which are each formed of two carbons inclined towards one another in the form of the letter V, and so shaped at their points as to meet and touch one another in a vertical plane passing through the axis of the apparatus. The two double electrodes are automatically maintained at a suitable distance apart by mechanism, while the fixity of the arc is insured by an electro-magnet arrangement.

1556. "Applying electro-plating and gilding to wood surfaces." HENRI ALEXANDER VICTOR WIRTH. Dated April 16. 2d. The wood carving intended to be plated is prepared by destroying by means of known acids the superficial molecules of the wood; the carving is then placed in an oven at a temperature of 200 degrees, more or less, and for a sufficient length of time to completely dry it. The surface of the wood is then covered with a coating of plumbago, and placed in an electro-plating bath.

1585. "Coils for electro-magnets, &c." GEORGE SCARLETT. Dated April 17. 6d. The electro-magnet is wound in sections, and all the sections are joined up for "quantity."

1649. "Electric lighting apparatus, &c." WILLIAM ROBERT LAKE. (A communication from abroad by Hiram Stevens Maxim, of Brooklyn, New York, United States of America.) Dated April 21. 8d. Relates to electric lamps producing light by a voltaic arc between two carbon electrodes, and especially to the class of such lamps known as hanging lamps, in which the clockwork or other machinery for feeding the carbons is located in a case above the focus; and an improved method of regulating such feeding mechanism; and an improved construction of the part of the lamp carrying the lower carbon and the globe.

1751. "Electric signal apparatus for railroads." WILLIAM MORGAN-BROWN. (A communication from abroad by Oscar Gassett, of Boston, Massachusetts, United States of America.) Dated April 29. 1s. Relates to electric signal apparatus for railroads, used in connection with that class of apparatus operating with a closed circuit in which the signals are operated by shunting or short-circuiting their controlling electro-magnets by the wheels and axles of a train or otherwise, the battery circuit remaining constant except when accidentally broken, as by the breaking of a rail or washing out of the track, or rupture of a wire or otherwise.

THE ANGLO-AMERICAN TELEGRAPH COMPANY'S Brest and St. Pierre Cable was reported broken on the morning of the 12th ultimo, at a distance of about 230 miles from Brest. The s.s. *Scotia* was ordered to proceed to effect repairs as soon as she could be got ready. It will be remembered by most of our readers that the Anglo Company has somewhat recently raised its tariff from 6d. to 2s. per word, except on the above-mentioned cable, as on this line of communication the French Government has some control by virtue of the landing concession, and it objected to the rate being again raised. Some people on this side regard the reported break, therefore, as a curious coincidence, and even go so far as to hint that the cable was purposely broken. We cannot, however, endorse this opinion; the authorities of the Anglo Company have much too great business capacity to allow them to wilfully damage their own property. Such rumours are manifestly absurd.

The following are the final quotations of telegraphs for the 30th ult.:—Anglo-American Limited, 64-64½; Ditto, Preferred, 92½-93½; Ditto, Deferred, 35-35½; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9¾-10; Cuba, Limited, 8¾-9¼; Cuba, Limited, 10 per cent. Preference, 16-16½; Direct Spanish, Limited, 2⅞-3⅛; Direct Spanish, 10 per cent. Preference, 12½-13; Direct United States Cable, Limited, 1877, 12¼-12½; Scrip of Debentures, 102-104; Eastern, Limited, 9⅜-9⅝; Eastern 6 per cent. Preference, 12½-12¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 102-106; Eastern 5 per cent. Debentures, repayable August, 1887, 102-107; Eastern, 5 per cent., repayable Aug., 1899, 104-107; Eastern Extension, Australasian and China, Limited, 10-10¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 105-107; Ditto, registered, repayable 1900, 105-107; Ditto, 5 per cent. Debenture, 1890, 101-103; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 103-104; Ditto, ditto, to bearer, 102-104; German Union Telegraph and Trust, 10-10½; Globe Telegraph and Trust, Limited, 6⅜-6⅝; Globe, 6 per cent. Preference, 12⅛-12⅝; Great Northern, 10⅞-11⅛; Indo-European, Limited, 25-26; London Platino-Brazilian, Limited, 5½-6; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 10¾-11¼; Submarine, 255-265; Submarine Scrip, 2⅜-2⅝; West Coast of America, Limited, 3¼-3½; West India and Panama, Limited, 1⅞-2⅛; Ditto, 6 per cent. First Preference, 6¾-7¼; Ditto, ditto, Second Preference, 6¼-6¾; Western and Brazilian, Limited, 8⅜-8⅝; Ditto, 6 per cent. Debentures "A," 106-110; Ditto, ditto, ditto, "B," 98-101; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 34½-35½; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3¾-4; India Rubber Company, 17¼-17¾; Ditto 6 per cent. Debenture, 106-108.

TRAFFIC RECEIPTS.

NAME OF COMPANY.	OCTOBER, 1880. £	OCTOBER, 1879. £	INCREASE OR DECREASE. £
Anglo-American.........	*	...	...
Brazilian Submarine ...	†16,620	†16,158	Inc. 462
Cuba Submarine	2,100	3,512	Dec. 1,412
Direct Spanish	1,821	1,370	Inc. 451
Direct United States ...	*	...	...
Eastern	47,570	50,251	Dec. 2,681
Eastern Extension	29,061	31,419	Dec. 2,358
Great Northern	22,480	...	...
Indo-European	...	...	...
Submarine	*	...	...
West Coast America ...	...	...	...
Western and Brazilian	‡11,572	...	...
West India	...	...	...

* Publication temporarily suspended. † Five weeks.

‡ The traffic receipts of the Western and Brazilian Telegraph Company will, from the 1st of October, be published exclusive of the fifth of the gross receipts payable to the London Platino and Brazilian Telegraph Company, Limited, which fifth has hitherto been included in the amounts published.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 189.

THE PHOTOPHONE.

THE discussion on the paper read on the 8th instant before the Society of Telegraph Engineers has gone far to confirm an opinion we expressed in our leading article published in our issue of the 1st November. We there stated that we doubted the accuracy of the conclusions drawn by Professor Bell with reference to the action of light upon matter; and the experiments made by Professor Tyndall seem to have conclusively proved that the effects observed are due to heat and not to light. We do not in the least desire to depreciate the work of Professor Bell; the experiments he has made are in the highest degree interesting and worthy of praise, though the cause of the effects produced may have been misapprehended.

According to Professor Tyndall the sounds produced are probably due to the alternate expansion and contraction of the particles of which the matter is composed under the influence of heat. The experiments are valuable in that they show with what great rapidity changes of temperature may be effected. In the case of the telephone it is shown with what great rapidity magnetic changes can take place.

It is well known that an ordinary electro-magnet takes a comparatively considerable time to become thoroughly magnetised, and an equally long time to become completely demagnetised. Similarly, any kind of matter takes a considerable time to become sensibly heated, and the heat is lost equally slowly. In the two cases we have referred to we have the changes taking place with great and unexpected rapidity. Where the changes are minute the rate of action is correspondingly rapid, and it seems probable that this is so in every physical action; in the case of the action of light upon selenium we have these rapid changes taking place. These facts seem not unlikely to have a considerable bearing upon the question of fast speed working on submarine cables; possibly by signalling by very minute changes in a current a corresponding high speed of transmission may be attained. We do not suggest any means of effecting the object, but we think that there is a field for inquiry in this direction.

MAXIM'S DYNAMO-ELECTRIC MACHINE ARMATURE.

THIS armature, the invention of Mr. Hiram Stevens Maxim, of Brooklyn, America, is shown by figs. 1 to 5.

The body of the armature is constructed of thin plates of iron of the form shown in fig. 4, and at A^2, in fig. 2.

These plates should be of the best annealed iron, and are provided with a series of "lodial" projections which serve as pole extensions. Part of the plates of the armature are made of the form shown in fig. 3, and at B^2, in fig. 2. These are provided with longer projections corresponding to the "lodial" projections of the other plates, and also with additional projections both on the outside and on the inside for the purpose of holding the wire of the coils in position. An armature is constructed by placing a sufficient number of plates alongside of each other, and fastening them together by means of pins or rods, H^2, H^2, made of some diamagnetic material passing through all the plates, as shown in fig. 2. The plates, however, are not placed directly in contact with each other, but are separated by washers upon the rods, H^2, H^2, of about the thickness of the plates, and interposed between them, or between pairs of them, so as to leave air spaces between the plates. Where the tension of the current is very great, as in machines for supplying electric lamps, the larger plates are made of some strong insulating material, a few of them, say, one to each end, and one in the middle being used, and they are made to project so as to keep the wire at some little distance from the iron and prevent all danger of a short circuit.

Where a current of low tension is required, all the rings are made of iron, and it is advantageous under some circumstances to use more of the larger rings, or even to construct the whole armature of them. The manner of winding the coils is shown in figs. 1 and 2, where C^2, C^2, represent the coils wound upon the armature and held in position by the projections on the large plates, B^2, so as to leave air passages between the coils, both upon the inside and upon the outside. The armature is attached to its shaft by means of a hub with spokes fitting into recesses in the rings, or by any other suitable device. It is important, however, that the space between the armature and its shaft should be left substantially open, so as to permit the free ingress of air, and a sufficient number of the plates shown at B^2, having the larger exterior and interior projections, should be used to keep the coils separated throughout their entire course, so as to leave an open passage for air between them. In order to secure the greatest advantages from this construction, the plates composing the armature should be made thin, and a considerable number of them used.

To obviate a sharp bend at the end of the coil, and the consequent injury to the insulation and increase of resistance, the end rings of the cylinder are constructed of half-round iron; this presents an easy curve for the wire at all points.

In other respects than those mentioned, the armature is similar in construction and operation to those which are now well known and in common use.

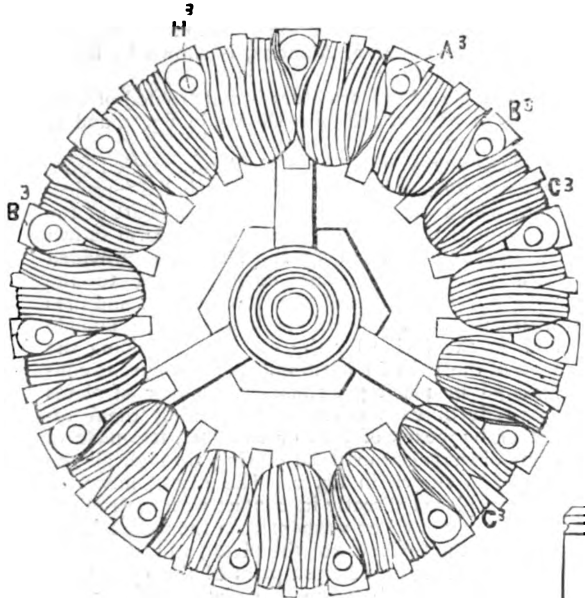


FIG. 2.

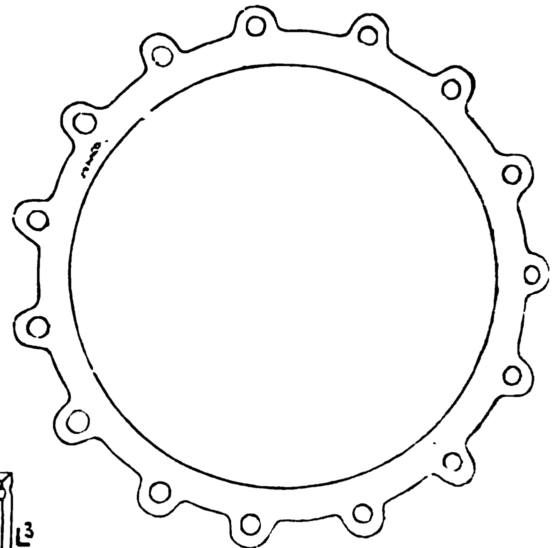


FIG. 4.

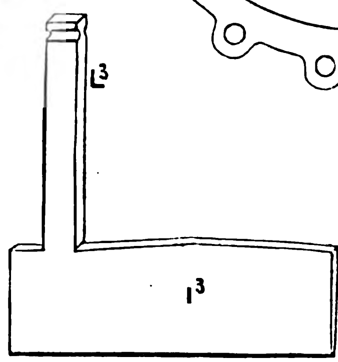


FIG. 6.

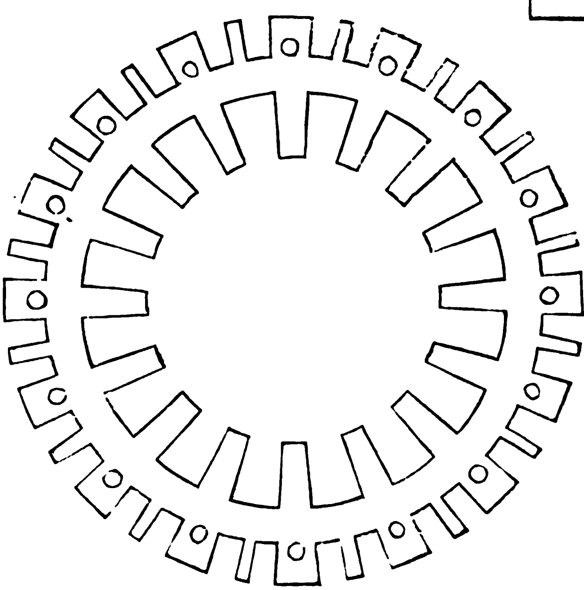


FIG. 3.

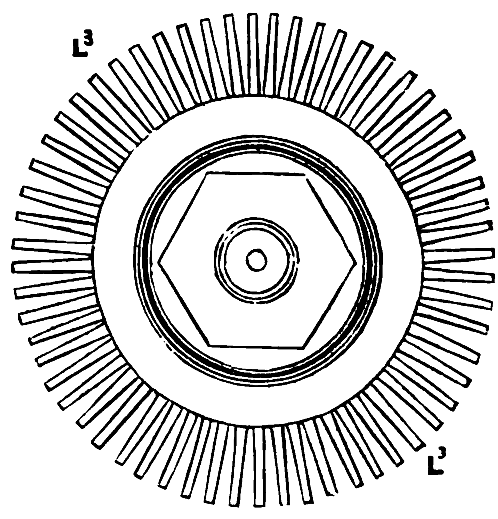


FIG. 5.

The construction of the commutator is best shown in figs. 1, 5, and 6. In fig. 6, one of the metallic plates forming the commutator is shown separately. These plates are made straight upon the edge toward the centre of the commutator-cylinder, but V-shaped upon the side forming the circumference, and each plate is made thicker upon the outside, so that a cross-section would be sector-shaped. The double spiral or V-shaped arrangement of the plates at the circumference is best shown in fig. 1. I^3, I^3, are the metallic plates, and K^3, K^3, are divisions of insulating material between them. Each plate has an arm, L^3, projecting radially, to which the coils are electrically connected in the usual way. As the brushes overlap several plates of the commutator when arranged in this way there is no danger of interruption or weakening of the current from the brush leaving one plate before making contact with another, and the plates do not work loose in their clamps or wear unevenly.

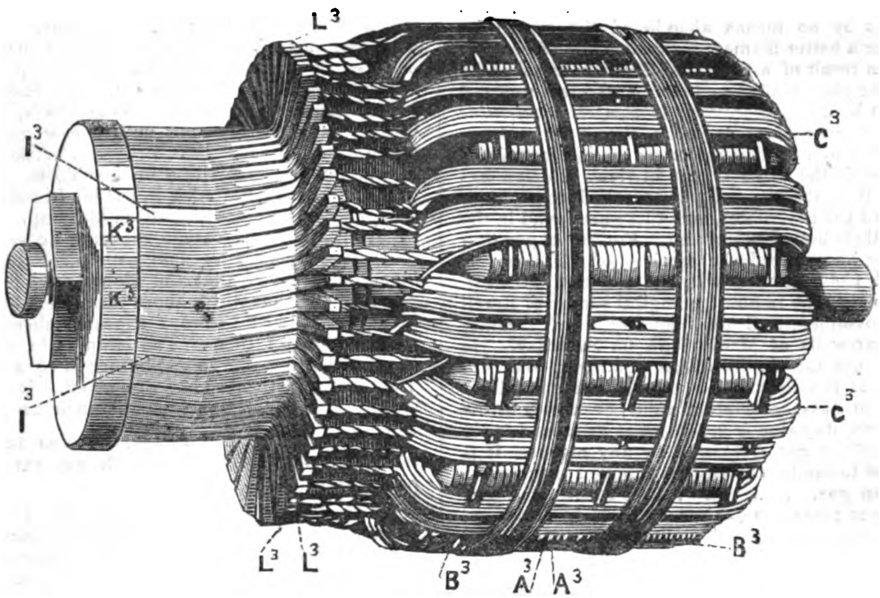


FIG. 1.

THE EDISON ELECTRIC LIGHT.

THE American press in speaking on this subject is so very amusing that we give a few quotations from some well-known papers of that country.

The special correspondence of the *Chicago Tribune* of November 13th contains the following :—

. . . . The visionary dreams of four years ago, the boundless expectations of a sudden and complete revolution in household illumination, and of consequent accession to enormous wealth, have been given up; and the periods of alternate excited hope and strong reaction of a year ago have also come to an end. in their place there are now an intelligent comprehension of the difficulties of electric lighting in households and of the impossibility of obtaining a perfectly durable lamp; and a determination *simply to make the most out of the invention already completed, such as it is.* Last week fully a hundred men worked literally night and day at Edison's shops, in the manufacture of lamps and in the work of experiments; and on Thursday and Friday nights the whole force were up nearly all night making elaborate tests on a scale hitherto never attempted. When I visited the spot Saturday noon, Edison, Bachelor, Upton, and the other principal men, were all still in bed, not having recovered from the fatigues of the previous night. Edison did not make his appearance until about 2 p.m. He then dragged himself out, and came up to the laboratory, looking a little pale and used up, but smiling in spite thereof, because things had gone to his satisfaction.

The lamp now being tried is a slight modification of the vacuum horseshoe carbon lamp. It is not different in principle, but only in form. It is longer and larger. The glass globe is in the form of an elongated lead plummet. It is about six inches long now from the point at the top to the end of the tapering portion below which fits into the chandelier. In the broadest part it is about three inches through. The carbon is a perpendicular loop made by bending double a filament six inches long. The increased length gives increased resistance. The light of the lamp is no longer that of *three* gas burners, but of *one* gas burner; that is to say, of sixteen candle-power. Like all previous lamps of the incandescent class, the light given by it is beyond criticism. It is a gleam of pure and mellow sunlight. It is as lustrous as the morning star. There is no flickering, no dazzling effect, no dark shadows, and little or no heat. Complete purity of the air is preserved, a fact which is now relied upon as one of the strong points giving it commercial value. The carbon is no longer made of the Manilla fibre, as that in last winter's lamp was, but of bamboo, which is found to serve the purpose better. The filament vaporises in

time, just as all its predecessors have done; and the interior of the glass bulbs of lamps which have, in Menlo Park phrase, "busted," is smoked dark with the fumes of the volatilised carbons. But it is believed by Edison that he now has a filament which will last for six months in ordinary use. The Manilla filaments lasted about 700 hours. It is claimed that one of them lasted for 1,700 hours; but only one did that. The bamboo-fibre carbons are expected to stand about 900 or 1,000 hours when perfectly made, or say six months in ordinary practice. This is now the limit of Edison's claim in regard to the matter. On first sight a lamp of such small durability seems of no great value; and, in fact, the probability of a sudden revolution in lighting by means of such an invention seems remote. Nevertheless, Edison believes that the lamp is good enough for use in business houses, and that the time has come to make an effort for its introduction. . . . . . . Edison has by no means abandoned the search for material for a better filament for carbon. The bamboo carbon is a result of a voyage to China undertaken by a man in the employ of the company, who was sent out to see what he could discover. *A competent scientific gentleman is now about to go to Brasil* to make a thorough research of that region in the interest of the company, with the same object in view. Edison has found that it is the class of plants called endogenous which afford the best fibres, and these are found in the tropics in their best development. For the expedition to Brazil he has secured the services of Mr. Branner, of Cornell College, who was the assistant of Prof. Hart in making the famous geological survey of Brazil for the Government of that country. Mr. Branner made his farewells at Menlo Park on Saturday. He leaves at once for the southern continent, and will begin work at Para. . . . . . While the new light is believed to have commercial value, even with all its imperfections, its value *is not so great as to lead to the extinction of the gas companies* by any means. It is not easy yet to see how it can be supplied much more cheaply than gas. . . . . . It is ascertained that there are over 1,000,000 gas burners in New York city. The average number lighted nightly is 500,000. Edison's light can be supplied the most cheaply if manufactured on a large scale. Supposing that it should be introduced throughout the city, it would cost as follows per year:—

Coal.—Three pounds per horse-power, giving six lights, 140,000 tons per year, at 3 dollars... ...	420,000 dol.
Labour.—Five men at each central station; twenty at main office; 200 for repairs, inspection, &c., at 20 dollars each per week ...	426,000 "
Lamps.—Three per light per year, at 35 cents	525,000 "
Depreciation, taxation, and repairs—15 per cent. at least—the plant costing 10,000,000 dollars ...	1,500,000 "
Dividends, 8 per cent.	800,000 "
Total ...	3,671,000 dol.

It would thus involve an expenditure of 3,671,000 dollars yearly to produce and maintain 500,000 lights—a moderate estimate, as the probability is that it would go over that sum, as there would be unforeseen expenses in operating a system of such novelty and complexity. The cost per light per year would be 7 dols. 34 cents. The cost per gas-light per year, at rates which companies can afford to concede, varies from 7 dols. 30 cents to 9 dols. 25 cents, according as the consumer is a large or small one. The advantage is in favour of the electric light, but the difference is not what has always been claimed. The claim which Edison used to make, that his lights can be supplied at about 3 dols. per year, is utterly unfounded. The above calculation is not altogether novel to men engaged in the manufacture of gas, but there are many private citizens holding gas-shares, but having no connection with the practical part of that industry, who might be thrown into sudden and unnecessary alarm were they not warned beforehand about the cost of the electric light, and against the demonstration about to be made at Menlo Park.

The *New York Herald* of November 18th says:—

A visit to Menlo Park found the unwearying Edison cheerily superintending the entry into his workshop of a four-ton bed plate for the new Porter engine, which he has been expecting some time. . . . . . The new factory was not working at its full force because of a leakage in his mercury pump, which supplied the 500 vacuum pumps. The leakage caused the salivation of a number of his *employés*, and obliged him to suspend operations until a new mercury-tight pump was procured. . . . . . . Asked about the Maxim lamp on exhibition in New York. Mr. Edison said that he had not seen it, but his friends had. He thought it was a clean steal from his lamp. He did not believe in the hydro-carbon vacuum; he smiled at the idea of plugging a vacuum with wax. It would be found, he believed, that the globes were fused at the point. "I do not worry about them, or a hundred like them," he said; "I always expected them, and there will be more of them. The lamp is to a system of electric lighting what a gas-burner is to a gas works. They know just what they are about. It is simply a stock-jobbing operation to float electric arc stock."

Puck, the American *Punch*, has also an article on the same subject, from which we extract a few paragraphs:—

As we thought it about time for the long-deferred illumination of Menlo Park to take place, we despatched a few of the members of our artistic and literary staff to Mr. Edison's establishment, in order that we might learn what progress had been made in Mr. Edison's experiments.

Mr. Edison received the *Puck* delegation with much cordiality, and, as he was busily engaged at the moment in perfecting the "Panto-Debagulator"—a machine for preventing trousers from bagging at the knees—he desired to be excused for a short period, but requested that the gentlemen would make themselves quite at home and look over the works as they pleased. He would afterwards join the party and explain anything that might not be clearly understood.

Mr. Edison afterwards explained that he had entirely rejected carbon points for the electric light. He had discovered that there was nothing equal to a tallow candle wick, provided it had a full supply of tallow encircling it. Experience had also taught him that an old-fashioned tin candlestick was the best kind of receptacle for the tallow candle.

On the topic of the electric railway it also says that—

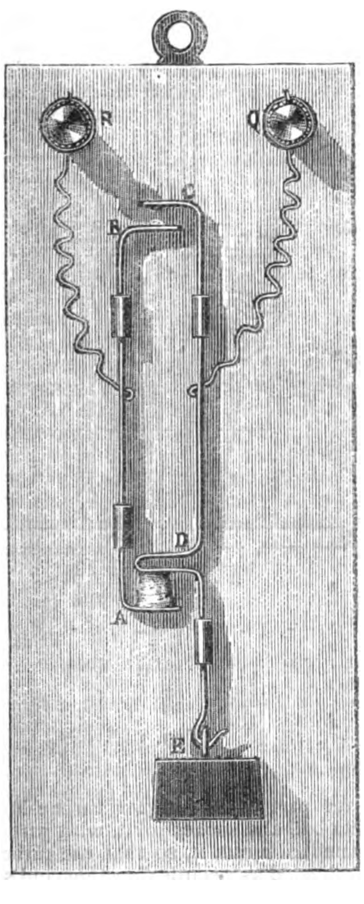
Mr. Edison had found that batteries and other paraphernalia that are usually associated with electric locomotors take up too much space. How was this obstacle to be surmounted? Many long nights and weary days did Mr. Edison ponder over this problem. Sometimes it appeared as though he had solved it—at others as if its solution was further away than ever. He had almost given up the subject in despair when a

sudden light burst upon him. Why not substitute for artificial generation of electricity, *Human Electricity?*

By putting a human being at the cast-iron crank, the needed motive power is supplied, and thus for the first time in the history of the world human electricity, combined with elbow grease, is utilised.

ELECTRIC FIRE ALARM.

A LARGE number of arrangements have been invented for announcing the presence of a fire by means of an electric bell set in action as soon as the temperature of the place where it is set has become raised above its normal degree. One well-known piece of apparatus consists of a simple



thermometer tube with mercury; when the latter expands by an elevation of temperature it completes the circuit with a platinum wire connected to a battery, and thus sets the bell in action.

M. C. Dupré has constructed, at M. Duboscq's residence, an apparatus based on the same principle, but the arrangement of which is new and original.

Two metallic tongues, A B, C D, are connected in the circuit of the battery and electric bell by the intervention of the buttons, R and Q. The tongue, C D, is separated from the first tongue, A B, which is fixed, by a small mass of tallow placed on the lower of the two tongues (*see* figure). If the temperature becomes raised by reason of a fire occurring, the tallow melts, the tongue, C D, drops under the influence of the weight, E, and comes in contact with the tongue, A B; the circuit is established, as explained above, with the upper part of the system, and the bell rings.—*La Nature.*

NEW ELECTRIC LAMPS.

MAXIM'S ARC LAMP.

THE chief peculiarities in the new lamp consist in an improved method of regulating the feeding mechanism, and in an improved construction of the part of the lamp carrying the lower carbon and the globe.

In electric lamps as usually made Mr. Maxim considers that the regulator is not sufficiently sensitive, as it requires too great a change in the strength of the current to cause it to act, and this has been the cause of unsteadiness in the light. In order to obviate this difficulty all friction is removed from the regulating device by suspending the working parts upon springs, which at the same time support the upper carbon and its feeding mechanism free from contact with all other parts of the lamp, and serve as frictionless conductors of the current to the carbon-holder.

Lamps as hitherto constructed have also been subject to another difficulty. It is frequently necessary to remove the globe in order to perfectly adjust the carbons when they are first put in, and in such lamps no means have been hitherto provided for setting or removing the globe when the carbons are of full length and adjusted without disturbing their adjustment. To obviate this difficulty the side rods which carry the globe-holder are made telescopic.

Fig. 1 is a front elevation and fig. 2 a side elevation of the new lamp. Fig. 3 (drawn to an enlarged scale) is partly an elevation and partly a central vertical section of the upper part of the same, showing the feeding mechanism and regulator.

A is the case containing the feeding mechanism and regulator; B is an axial magnet or coil, and C the iron core of the same; D is a brass extension of the magnet-core screwed into its upper end, and extending some distance above it.

This extension, D, carries the train of clock-work, E, which is of the usual form used in such lamps, and the magnet-core and its extension are suspended upon the springs, T, T[1], and I. F is a star wheel mounted upon the most rapidly moving shaft, and carrying one or more fans; G is a stationary detent affixed to the case, A; H is a controlling clamp or dash-pot connected with the magnet-core and its extension to prevent the too rapid movement of the parts. The perpendicular spiral spring, I, is hung upon the two adjusting screws, J and K. The nut of the screw, K, has a fan-shaped projection bearing loosely against the side of the case to keep the spring from turning.

The screw, K, is attached to the case, A, and the screw, J, is attached to a projecting arm, S, of the

magnet-core, so that the spring, I, tends to support the core with its extension and connected mechanism, and the tension of the spring may be readily adjusted either from above or below. L is a combined hook and lever pivotted to the case, A, and fitted to hook over the projection, S, and thus hold up the parts connected therewith. This hook is provided with a lever-handle for convenience of manipulation, and has a spring, R, bearing upon it like the back spring of a knife, and so arranged that the lever has two positions of rest—that is to say, one when the hook is thrown forward and one when it is thrown back. N is the positive binding screw, and O is the negative binding screw. The of insulating material, and support the globe-holder, X. These rods are made hollow, and other rods rigidly attached to the globe-holder are inserted in them longitudinally. This construction is shown in fig. 1, where the rod, *d*, is represented partially in section. *c* is the interior rod, and *a* is a head attached to it to bear against an interior shoulder at the lower end of the tube, *d*, and prevent an entire separation of the parts. U, U, are short projections on the rods, *d*, *d*, bevelled on their lower sides, and V, V, are spring-catches, which are hinged to the globe-holder, and which hook over the projections, U, U, and hold the globe-holder up.

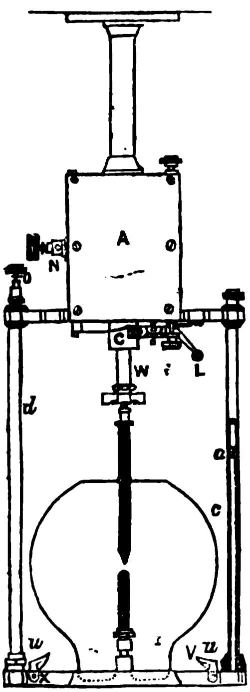


FIG. 1.

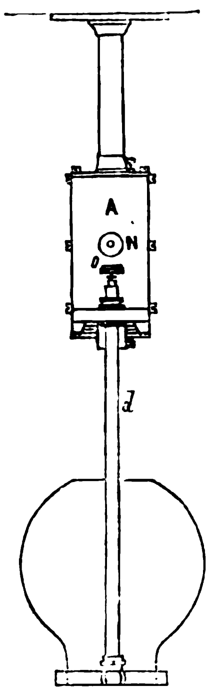


FIG. 2.

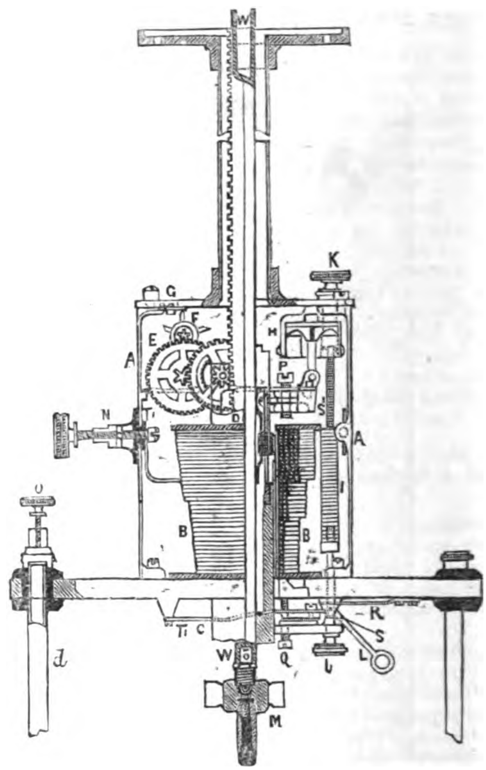


FIG. 3.

positive wire is carried from the interior end of the screw, N, to the coil of the magnet, B, and passes thence to the case, A, from which it is conveyed to the upper carbon-holder. A metallic spring is attached to the core extension, and presses lightly upon the inclosed spindle to insure perfect electrical connection between the parts.

The binding screw, O, is electrically connected with the lower carbon-holder by the side rod, *d*, and the globe-holder, X. P and Q are set screws to limit the vertical movement of the magnet-core and its connected parts. The flat, horizontal springs, T, T^1, are attached at one end to the case, A, and at the other to the projections, S, S^1, affixed to the magnet-core and its extensions. The side rods, *d*, *d*, are attached to the case, A, with a joint

The lower part of the upper carbon-holder is made with a ball and socket joint, with part of the socket formed of a nut, M, so that the carbon may be readily adjusted as regards direction, and secured firmly in position by turning the nut. The upper carbon-holder is carried by a spindle, W, passing longitudinally through the magnet-core and its extension. This spindle has a rack on one side, which engages with a small pinion of the train of clock-work on the shaft having the slowest movement, but otherwise is free to move longitudinally.

The operation of the lamp is as follows :—The magnet-core, C, and its extension, D, have a free vertical motion within the coil, B, and are suspended upon the horizontal, flat springs, T, T^1, and the spiral spring, I, as above stated; and as the magnet-core

is located somewhat lower down than its coil, it constantly tends to rise when the coil is excited by a current of electricity. The spindle, W, is supported by the train of clock-work only, and its weight is so adjusted that it will descend slowly when the gearing is free to move. The tension of the supporting springs is so adjusted to the weight of the magnet-core and the parts which it carries that the train of gearing shall hang just low enough to clear the detent, G, when a current of ordinary strength is passing. The gearing then slowly turns, and the spindle, W, descends, bringing the carbons together to supply the consumption at the focus.

If the points approach too closely to each other, the current increases in strength, the magnet-core is drawn in, the upper carbon is retracted, and the feeding mechanism is arrested by the detent, G. If, on the other hand, the points become too widely separated, the current is weakened, the magnet-coil loses its power, and the core descends and advances the upper carbon; at the same time the gearing is released from the detent, and the feeding process proceeds.

The apparatus may be adjusted with very great nicety by means of the adjusting screws, J and K, and the spring, I; and as the moving parts are freely suspended, and nicely balanced upon the supporting springs, a very slight change in the current passing through the coil is sufficient to bring the gearing into contact with the detent or to release it.

Whenever it is desired to stop the light, the hook, L, is sprung over the arm, S, and the feeding mechanism is by one operation retracted and locked.

Whenever it is necessary to renew the carbons, the spindle, W, is pushed up (a ratchet in the gearing allowing it to move upward freely), and the globe is removed. When the new carbons are adjusted to position, the globe-holder is depressed by pressing down the catches, V, V, and drawing out the telescopic side rods, the globe is replaced over the lower carbon, and the globe-holder returned to its former position without disturbing the adjustment of the carbons.

KRIZIK AND PIETTE'S ARC LAMP.

THIS lamp effects automatically the regulation of the distance of the carbons without the aid of clockwork or other like mechanism, by the use of solenoids having special cores, such solenoids and cores being applicable where, as in electric lamps, uniformity of attractive force has to be maintained throughout a considerable length of stroke. Two solenoid coils are placed end to end, with their axes in the same straight line, and with one iron core free to slide lengthwise within both, this core carrying at its end one of the carbons of the lamp, and being balanced when it is vertical, or running on rollers when it is horizontal. The one solenoid coil of low resistance is in the lamp circuit; the other of high resistance is in a branch circuit connecting the conductors to and from the lamp. The core is so shaped that so long as the two solenoids exert equal attractive forces it remains stationary, notwithstanding that it may have been previously moved lengthwise, so as to extend farther into or through the one coil than the other; and in order that it may have this property it is made with the mass of its metal reduced towards the ends. This may be done either by tapering it from the middle of its length to a less diameter at each end, or by boring it from each end with a tapering bore; or, instead of giving the metal a regular taper externally or internally, its diameter or thickness may be reduced by steps from the middle each way. Or it may be made of a number of pieces of iron rod or tube united end to end, with pieces of non-magnetic material of different lengths intervening between the lengths of iron. The core so constructed, carrying one of the carbons, will then adjust itself, moving the one carbon to or from the other, until the attractive forces exerted on the core by the two solenoids in opposite directions become balanced. When the carbons are too near the resistance of the arc is so far lessened that the solenoid in the circuit of the carbons becomes the more powerful of the two, and the core thereupon moves so as to separate the carbons. When, on the other hand, the carbons are too far apart, the resistance of the arc is so much augmented that the solenoid in the circuit of the carbons becomes the weaker, and the core thereupon moves so as to bring the carbons nearer together. According to a modified arrangement, when it is desired to retain the voltaic arc in one position, each of the carbon holders has attached to it a half taper, or stepped core, such as has been described above, each half core being free to move longitudinally within one of the solenoids; and the carbon holders are connected together in the usual way by gearing, so as to move in opposite directions through spaces proportioned to the relative rates of consumption of the two carbons. It is of advantage to combine with the lamp an automatic shunt of any known construction, so that when the lamp is extinguished the current is shunted into the general circuit.

Figs. 1, 2, 3, and 4, show the principles on which the new lamp is founded. If an iron core of uniform section, as shown in fig. 1, be placed within two solenoid coils, S and S^1, of equal magnetic force, the attraction on the core will depend on its position relatively to the coils; it is strongest when one end of the core is in the middle of the coil, and weakest when the middle of the core is in the middle of the coil. Hence, when the core is in the position shown in fig. 1, it will be more strongly attracted by S^1 than by S. When, however, the mass of the core at different parts of its length varies, the attraction of the two coils upon it may be equalised. Thus, by making the core in the form of a double cone, as shown in figs. 2, 3, and 4, notwithstanding the different positions occupied by the core, it remains equally attracted by the two coils, S, S^1, figs. 2 and 4 showing its extreme positions each way, and fig. 3 its middle position. The core, instead of being truly tapered towards each end, may be reduced by steps, as indicated in fig. 5; or it may be hollowed out by tapering holes, as in fig. 6; or it may be made up of a number of separate lengths of iron connected together by non-magnetic material, as indicated in fig. 7; and these lengths may be bored through with holes of different diameter, as indicated in fig. 8. By thus constructing the cores they may be made to move over considerable distances without under-

FIG. I.

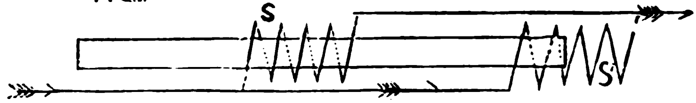


FIG. 2

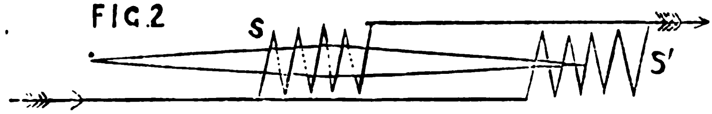
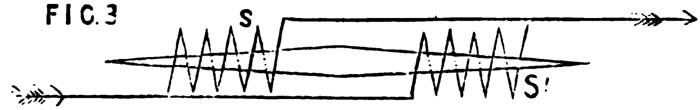


FIG. 3



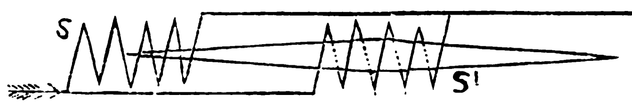


FIG. 4.

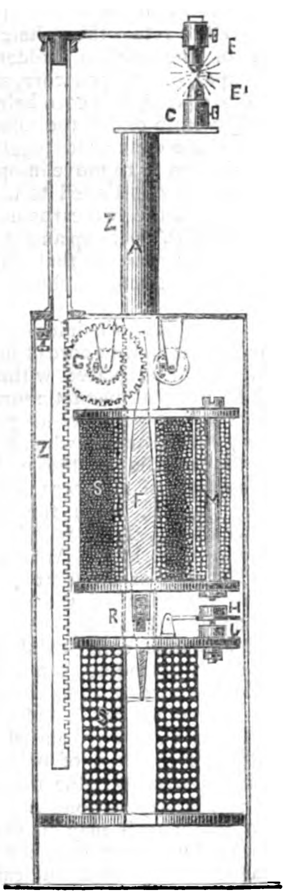


FIG. 11.

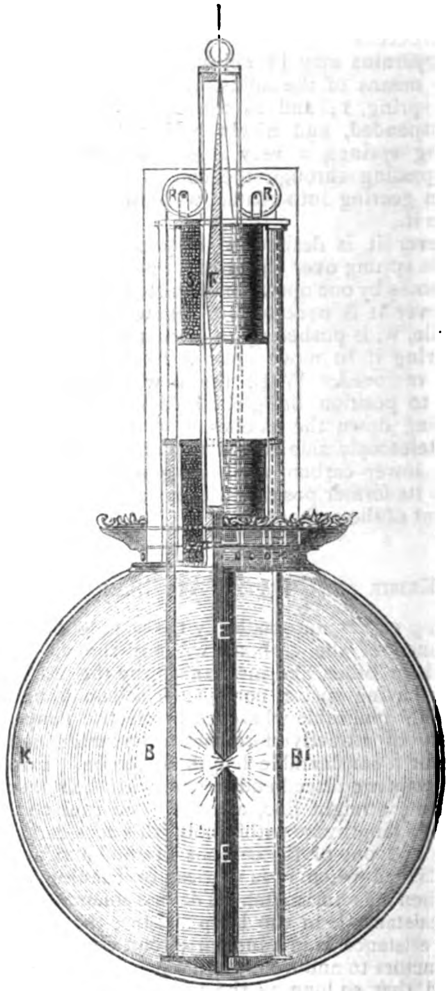
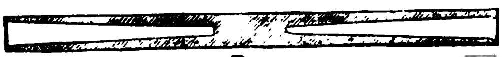


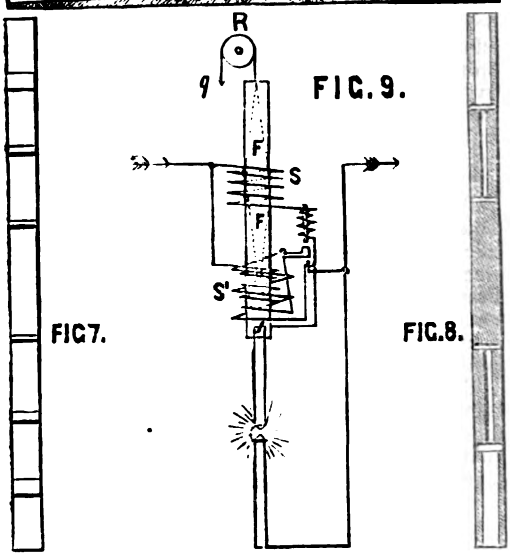
FIG. 10.

going change of attraction, and they are, therefore, suitable for regulating the distance of the carbons in electric lamps. Figs. 9, 10, and 11, show various constructions of lamps in which they are so applied. In fig. 9 the double-coned core, F, is attached to the socket of the upper carbon, the whole being balanced by a weight, *q*, attached to a cord passing over a pulley, R, and free to move within the two solenoid coils, S and S[1]. The coil, S, of large wire presenting small resistance is in the circuit of the carbons, and S[1], in a shunt circuit, consists of fine wire in many convolutions, so as to get with a weak current magnetic force equivalent to that of S with a strong current, and to present considerable resistance. When the carbons are too near, the attractive power of S being increased while that of S[1] is diminished, the core, F, is attracted upwards,

FIG. 5.

FIG. 6.





separating the carbons. When, on the other hand, the carbons are too far apart, S loses force and S[1] gains force, so that the core, F, is attracted downwards, causing the carbons to approach. In fig. 10, showing a pendant lamp partly in elevation and partly in section, the core, F, and upper carbon, E, with its socket are balanced by the lower carbon, E[1], and the rods, B, B[1], which carry it, the pulleys, R, R[1], over which the balancing cords pass, serving as guides to the socket tube of the upper carbon. In this lamp the connections and action of the two solenoid coils, S, S[1], are as described with reference to fig. 9. A standard lamp, arranged to maintain a constant focal position of the arc produced by a continuous current, is arranged as shown at fig. 11, the racks, *z*, *z*[1], of two carbon sockets being connected by insulated gear, G, D, proportioning their movements to their respective rates of consumption. The shunt coil, S, may consist of two or more layers of thick insulated copper wire furnishing the convolutions required, with several layers of thin copper and German silver wire to provide the required resistance. An electro-magnet, M, acting on an armature contact lever, H, serves to short-circuit the coil, S, in case of interruption of the lamp circuit.

This lamp has recently been tried at the rooms of Messrs. Wells & Co., Shoreditch, we believe with considerable success.

THE ROYAL SOCIETY.

ADDRESS OF THE PRESIDENT.

THE anniversary meeting of the Royal Society was held on November 30th, when the President, Mr. W. Spottiswoode, D.C.L., LL.D., delivered the inaugural address.

In the first portion Mr. Spottiswoode alluded to the losses which the Society had sustained through the deaths of Professor Miller, Dr. Sharpey, Mr. Lassell, Professor Ansted, Lord Belper, Mr. E. W. Cooke, Sir Benjamin Collins Brodie, and others.

In the year 1880 123 papers had been received by the Society and published. The Society receives annually from Government the sum of £1,000 for promoting scientific investigation; none of this amount is applied to the personal remuneration of the applicant. The Society has also practically at its disposal a further sum of £4,000 in connection with the Government Science and Art Department.

The law relating to vaccination, the Royal Commission on accidents in coal mines, the voyage of the *Challenger*, and the work of the Meteorological Office, were alluded to.

Amongst the duties of the President is assistance in the organisation of the City and Guilds of London Institute. The work done in the latter was fully alluded to.

The progress made in spectrum analysis was next referred to.

With reference to the progress in electrical science, Mr. Spottiswoode spoke as follows :—

"The striking advances made in electricity during the last few years, and marked by, amongst other things, the inventions of the telephone and the microphone, have been followed by a step not less daring in its conception, nor less successful in its execution; I allude, of course, to the photophone, of the result of the researches of Mr. Graham Bell and Mr. Sumner-Tainter. The principle of this instrument is already known. A powerful beam of light is first thrown upon a flexible mirror, the curvature of which is modified through vibrations set up in it by the human voice. The reflected beam is then received by some selenium suitably disposed, and forming part of an electric circuit. The intensity of the light so received, and with it the resistance in the circuit due to the selenium, varies with the varying curvature of the flexible mirror. A large parabolic mirror is used at the distant station to concentrate the light on the selenium 'cell;' and a telephone in the circuit reproduces the variations in the form of sound.

"Mr. Bell has, however, also shown that rays from the sun, or an electric lamp, when rendered intermittent by any convenient means, will set up in a plate of almost any substance vibrations correspond-

ing to the intermittence. The substances as yet tried are: metals of various kinds, wood, india-rubber, ebonite, &c., and among them zinc appears to be one of the best suited for the purpose. This result, which is independent of any electric action, is, perhaps, due to heat rather than to light.

"In these, as in many other issues of scientific research, we can hardly fail to be impressed by the almost inexhaustible resources which lie ready to hand, if we only knew how to use them, for the interpretation of nature, or for the practical purposes of mankind.

"During the past year Professor Hughes employed his induction balance for the detection of very minute impurities in small masses of gold. Mr. Preece also has shown how slight increments of temperature in fine wires transmitting telephonic currents of electricity will suffice to reproduce sonorous vibrations, and even articulate speech at a distant station by their influence on thin platinum wires, only six inches in length.

"Mr. Stroh has shown that, at the point of contact of two metals carrying strong electric currents, adhesion takes place, varying with the nature of the surfaces in contact; and that many of the effects at points of contact, previously attributed to induction, may be due to the peculiar action now for the first time brought under notice.

"It is worthy of record, that two Atlantic cables have been successfully laid during the present year; but that success in the operation has become so much a matter of course that its occurrence has attracted little public attention. Two cables, each of more than 500 miles in length, have been laid across the Mediterranean; and the Cape Colony has been placed in telegraphic communication with this country by a cable of not less than 4,400 miles.

"Constant attention is paid in the General Post Office to the introduction of improved methods for the furtherance of the telegraphic communication throughout the country.

"Steady progress has been made in bringing the electric light into practical use. The illumination of the Albert Dock of the London and St. Katherine's Dock Company, the Liverpool Street Station of the Great Eastern Railway, the St. Enoch's Station of the Glasgow and South-Western Railway, and last, but not least, that of the reading-room of the British Museum, have become accomplished facts; while the City authorities have decided to extend the use of this light over various thoroughfares under their control. The subdivision of the light for domestic purposes is a problem which appears to have found a solution in the incandescent carbon lamp of Professor Swan. Beside this, Mr. J. H. Gordon has devised, for the same purpose, a very ingenious application of rapid sparks from alternating machines, such as that of De Méritens, to produce incandescence in refractory metals. Lamps constructed on this principle completely fulfil the conditions of subdivision, but some difficulties of detail still retard their adoption for general use. There is, however, every reason to hope that the experience already gained, and the intelligence at present brought to bear upon it, will before long supply us with more than one form of domestic light.

"The Conference on Lightning Conductors, composed of delegates from the Royal Institute of British Architects, the Society of Telegraph Engineers, the Physical Society, and the Meteorological Council, is steadily pursuing its labours. A large mass of facts has been accumulated; several leading questions have been decided; and it is hoped that, in the course of the coming year, the Report of the Conference will be issued.

"One of the most interesting, and at the same time useful, applications of the dynamo-machines, is that of transmitting mechanical power to spots, or under circumstances, where the ordinary appliances cannot be conveniently used. Their principle will doubtless by degrees extend itself over a wide range of industry, especially in localities where water-power is abundant. Perhaps one of the most remarkable instances of the application of the principle is that by Dr. Werner Siemens of the propulsion of railway carriages in Berlin.

"Our Fellow, Dr. C. W. Siemens in London, and M. De Méritens in Paris, have demonstrated the use of the high temperature of the electric arc in fusing refractory metals. The method of operation, while peculiarly convenient for laboratory purposes and for demonstration, promises to be capable of extension, even to the large demands of commerce and manufacture.

"I should not, moreever, omit mention of the very beautiful experiments by Dr. C. W. Siemens, on the effect of the electric light on the growth of plants, on the opening of flowers, and on the ripening of fruit. On this subject we hope to hear more after the experiments which he has already commenced, and which he contemplates continuing during the coming winter.

"I am not sure how far the fact is known to the Fellows of the Royal Society, that the Society of Telegraph Engineers has thrown open to the scientific world a remarkable collection of books on electrical science, collected by our late Fellow, Sir Francis Ronalds, and bequeathed by him to that society. The catalogue, compiled by the collector, is a monument of concentrated and well-directed labour."

The latter part of the address referred to the transit of Venus and the preparations being made for observing the same in the year 1882. The calculations made in connection with the observations taken in 1874 are not yet completed.

THE TELEPHONE CASE.*

In the High Court of Justice. Exchequer Division.

Before MR. BARON POLLOCK *and* MR. JUSTICE STEPHEN.

THE ATTORNEY-GENERAL *v.* THE EDISON TELEPHONE COMPANY, LIMITED.

THIS was a proceeding, technically said to be "by way of information," instituted by the Post Office for the purpose of determining whether the defendant company had infringed the monopoly of the Postmaster-General, given to him under the Telegraph Acts. There is another case pending against the Bell Telephone Company, which stands over until the determination of the present one, both cases having been instituted before the amalgamation of the two companies.

The printed pleadings comprise an "information,

* Specially reported for this JOURNAL by A. B. KEMPE, Esq. Barrister-at-Law.

in which the Attorney-General informs the Court of the matters complained of, and requests that certain prayers may be answered; an "answer" of the defendants, denying some of the allegations of the information and adding others; "admissions" by the defendants as to their mode of carrying on business; and a "replication" of the informant joining issue with the defendants. The material paragraphs of these pleadings were as follows:—

The Information.

1. By the 31 and 32 Vic., cap. 110 (1868), the Postmaster-General is empowered to take over and work certain telegraph "undertakings." By sec. 3 of that Act "The term 'undertaking' shall mean the whole or any part of the electric and other telegraph wires, posts, pipes, tubes, and other works, instruments, materials . . . . and all other property whatsoever of any company, corporation, or persons engaged in the United Kingdom in transmitting messages for money or other consideration by means of electric or other telegraphs." And "The term 'any company' shall mean any company, corporation, or persons now engaged in the United Kingdom in transmitting or authorised to transmit messages for money or other consideration by means of electric or other telegraphs or mechanical agencies."

2. By the 26 and 27 Vic., cap. 112 (1863), which is referred to in the Act of 1868, it is enacted in sec. 3 that "The term 'telegraph' means a wire or wires used for the purpose of telegraphic communication, with any casing, coating, tube or pipe inclosing the same, and any apparatus connected therewith for the purpose of telegraphic communication." And "The term 'post' means a post, pole, standard, stay, strut, or other above-ground contrivance for carrying, suspending, or supporting a telegraph."

3. By the Telegraph Act, 1869 (32 & 33 Vic., cap. 73), sec. 4, "The Postmaster-General by himself or by his deputies and his and their respective servants and agents shall from and after the passing of this Act have the exclusive privilege of transmitting telegrams within the United Kingdom except as hereinafter provided, and shall also within that kingdom have the exclusive privilege of performing all the incidental services of receiving, collecting, or delivering telegrams except as hereinafter provided." By sec. 5 of the same Act, "There shall be excepted from the said exclusive privileges of the Postmaster-General all telegrams of the following descriptions: telegrams in respect of the transmission of which no charge is made, transmitted by a telegraph maintained or used solely for the private use and relating to the business or private affairs of the owner thereof: telegrams transmitted by a telegraph maintained for the private use of a corporation, company, or person, and in respect of which or of the collection, receipt, and transmission or delivery of which no money or valuable consideration shall be or promised to be made or given." There are other exceptions, the only material one of which is, "telegrams transmitted with the written licence of the Postmaster-General."

4. The Telegraph Act of 1878 extended the operation of the former Acts to underground cables and pneumatic apparatus.

5. The Postmaster-General acquired the monopoly at a cost of over £10,000,000, and the yearly revenue is £1,250,000, of which nearly £200,000 is clear profit, and it is essential to protect the public revenue that the monopoly should be enforced.

6. Sets out the material parts of the Memorandum of Association of the Company.

7. Refers to the two patents of Edison worked by the Company. These are (1) a patent, No. 2909, dated 30th July, 1877, for "Improvements in instruments for controlling by sound the transmission of electrical currents and the reproduction of corresponding sounds at a distance." (2) A patent, No. 2396, dated 15th June, 1878, for "Improvements in telephones and apparatus employed in electric circuits."

8. Points out that it appears from the two specifications that the inventions include wires for the purposes of telegraphic communication, and apparatus for transmitting messages and other communication by means of electric signals.

9. Quotes from the earlier specification passages describing the inventions as "The acoustic or speaking telegraph," "a telegraph operated by sound," "an instrument for transmitting sounds by electricity," "an instrument for receiving sound telegraphically."

10, 11. Are immaterial.

12. In this paragraph the Attorney-General informs the Court that the wires and apparatus employed by the defendants constitute a telegraph, and gives an elaborate description of the instruments employed.

13 and 14 set out printed notices of the Company, stating the advantages of their system, and the terms on which they deal with customers.

15 and 16 set out a lengthy article from the *Times* of Monday, Sept. 8th, 1879, describing the mode in which the Company carries on business by the well-known Exchange system.

17. States that the Company, as a matter of fact, do carry on their business in the mode described by the *Times* article, and asserts that in so doing they have "transmitted or aided in and permitted the transmission of messages."

18. Sets out the Company's advertisement, which has appeared in several newspapers, and says that they act as therein stated.

19. Asserts that the wires of the system are not private wires, so as to bring the case within the exceptions of sec. 5 of the Act of 1869, but are at any rate as to part common to many subscribers.

20. Sums up, by re-asserting that the apparatus employed are telegraphs, that the messages are telegrams sent by the defendants for hire, and that the revenue will be seriously injured if they are allowed to carry on their business unchecked.

21, 22, 23, 24, 25, 26. Contain a correspondence between the defendants and the Post Office on the subject, in which the latter states that it "will not sanction the transmission of messages to greater distances than half-a-mile from the centres, not allow two or more centres to be connected;" and the former state that they "are advised by eminent counsel that the exclusive privilege of transmitting telegrams does not extend to the use of telephones in the manner proposed by the Company, and therefore do not propose to apply for a licence from the Postmaster-General."

27, 28. Give an account of a visit of inspection to the Company's Central Exchange by Mr. Graves, the Engineer-in-Chief, and Mr. Preece, the Electrician to the Post Office.

29. States that the Attorney-General waives all penalties.

The Information, in conclusion, prays:—

(1) That it may be declared that the wires and apparatus of the defendant Company are telegraphs within the meaning of the Telegraph Acts, and that messages or other communications transmitted by means of any such wires are telegrams within the meaning of such Acts.

(2) That it may be declared that the transmission by or with the aid or permission of the defendant Com-

pany, by means of any such wires and apparatus, of messages or other communications under or by virtue of contracts entered into upon the terms mentioned in the notices published and circulated by the Company, or upon any terms under which any money or other consideration is or shall be paid or given or promised to be paid or given to the Company, or of any other messages or other communications in respect of which, or of the collection, receipt, transmission, or delivery of which any money or other consideration has been or shall be paid or given or promised to be paid or given to the defendant Company, is an infringement of the exclusive privilege conferred on the Postmaster-General by the Telegraph Act, 1869.

(3) That the Company, their servants, and agents may be restrained from infringing that privilege.

(4) That an account may be taken of all moneys received by the Company in respect of the messages passing along their wires, with a view to the same being paid into the Exchequer.

(5) That such further or other relief may be given as the case may require.

THE ANSWER.

1, 2. Are immaterial.

3. States that "the Edison telephone, which is alone supplied by the Company, is an instrument for reproducing the words of audible and articulate speech by means of or with the aid of electricity. It enables two persons, without any previous acquaintance with the instrument, and without any code of signals, to converse directly with each other without the intervention of a skilled operator or any other person to transmit or interpret the communication. The Company was not formed for the purpose of transmitting messages, and they do not transmit messages, and they do not intend to transmit messages. Their only object is to lease telephones to corporations, companies, and persons, and to fix the private wires necessary to complete the electric connection and to maintain such telephones and wires in proper working order. The Company do not collect, receive, transmit or deliver any telegrams or other messages between any persons whatever, and they never let a telephone except under a contract in writing by which it is expressly stipulated that the telephone and apparatus, or the telephone, apparatus, and wire (as the case may be), are solely for the private use of the lessee, and are to be used exclusively for conversation by him, his clerks, servants, and others authorised by him, on matters relating to his business or private affairs, and are not directly or indirectly to be used in any way or manner for the transmission of messages for the public, and that the lessee shall not allow the same to be used for money or other valuable consideration by any person or persons whatsoever."

4. States that the operations of the Company are conducted in four different ways:—

(*a*) It leases telephones.

(*b*) It leases a pair of telephones and a private wire.

(*c*) It leases the telephones and sells the wire after fixing it.

(*d*) It works the well-known "exchange system."

5. Says that though no doubt the Company's wires might be used "for the purpose of telegraphic communication," and its apparatus "for transmitting messages and other communications by means of electric signals," still as a matter of fact they are never so used.

6. What is done is: "Two telephones by means of which articulate speech is reproduced are always connected by means of a wire extending from the speaker to the listener, and such wires are similar to the wires commonly used for the purpose of transmitting messages by the electric telegraph. But it is not the fact that any messages are transmitted by the apparatus so supplied by the Company."

7. The Company's apparatus reproduces at the receiving station sonorous vibrations of air corresponding to those produced at the transmitting station by the direct action of the human voice. "There is no preconcerted code of signals, and there is no third person interposed . . . . to interpret any such signal or to collect any message; and except in so far as actual speech between any two persons can be called a message (which the Company submit it cannot) any communications which pass are not telegraphic communications, nor are the instruments telegraphs, either within the meaning of the acts of Parliament or in ordinary language." In telegraphs, it is alleged, "the electricity or other efficient cause is usually put into action by the mechanical agency of the hand of the person transmitting the message."

8. Describes very fully the apparatus employed by the Company, including the "switch-board," by which the various subscribers are put into communication with each other, and the call-bell, as to the ringing of which "the Company submit to the judgment of the Court whether this is or is not an electric signal."

9, 10. Contain admissions by the Company as to the truth of paragraphs 12, 13, and 15 of the Information.

11, 12. State that the only places of business of the Company are the central exchanges, the terminal stations being the private places of business of the customers of the Company.

13. Is a general assertion that the Company have not violated the monopoly of the Postmaster-General, inasmuch as they have received no money for the transmission of messages or the communication, collection, or delivery of such.

14. Admits the correspondence referred to in the Information.

15. Admits the visit of Messrs. Graves and Preece to the central exchange.

16. Minutely describes the proceedings of the switch-boy at the central exchange, admitting that he has to be communicated with by the transmitter in order that the latter may be put into direct communication with the receiver.

17. Relates to certain agreements of the Company.

18. Asserts that no messages are transmitted by the Company, nor, as far as they are aware, by their customers, and that the only apparatus employed by the Company is telephonic.

19. States that the telephone was not invented until long after 1869, and at that date "no human being had the slightest idea that it would be possible so to extend the power of speech as to enable persons at a distance to converse with one another. There is no real similarity between the telephone and the various instruments used for telegraphic communication at the date of the passing of the Telegraph Act, 1869. The Company submit that there is no ground for so enlarging the monopoly conferred upon the Postmaster-General as to include the results of an instrument differing not merely in degree but in kind from the only instruments known or conceived of in 1869, and that the telephone is not a telegraph, and that direct conversation between any two persons by means of a telephone which reproduces audible and articulate speech is not the transmission of a telegram within the meaning of the Telegraph Acts."

20. The Company submits that even if a telephone is a telegraph, the operations of the Company fall within the exceptions of sec. 5 of the Act of 1869.

The admissions made by the defendants were as to

the existence of trunk wires used in common by different subscribers.

The case came on for hearing on Monday, 29th November, and lasted until the middle of the following Friday. The Attorney-General (Sir H. James, Q.C.), the Solicitor-General (Sir F. Herschell, Q.C.), Mr. E. E. Kay, Q.C., Mr. C. T. Simpson, Mr. W. W. Karslake, and Mr. J. F. Moulton, F.R.S., appeared for the Crown; Mr. Benjamin, Q.C, Mr. Webster, Q.C., and Mr. Cozens-Hardey (instructed by Messrs. Waterhouse and Winterbotham), appeared for the defendants. A great variety of apparatus was in court.

The ATTORNEY-GENERAL in opening the case for the Crown, stated that the present proceedings had been commenced on the 27th of November, 1879, in order to vindicate those rights of the Crown which had been placed in the custody of the Postmaster-General by the Telegraph Acts. The Crown did not ask for any penalties in this case, but wished that a monopoly which was exercised for the public benefit should be enforced. He referred briefly to the 7th and 8th Vic., cap. 85, sec. 13, 14, which compelled railway companies to permit telegraph lines to be laid alongside their rails, and to allow all persons "without favour or preference" to use such lines; and to the 24th and 25th Vic., cap. 97, sec. 37, which protected telegraph lines from injury. Prior to the Post Office Telegraph Acts, the telegraph companies were subject to the Act of 1863 (26th and 27th Vic., cap. 112). In 1868, by the 31st and 32nd Vic., cap. 110, the Postmaster-General was empowered to purchase the existing inland telegraph undertakings, and in 1869, by the 32nd and 33rd Vic., cap. 73, the exclusive monopoly in the transmission of messages was given to him. By the preamble of the latter Act it is stated that "in order to protect the public revenue, it is expedient that similar powers to those conferred upon the Postmaster-General with respect to the exclusive privilege of conveying letters should be enacted with reference to the transmission of public telegraphic messages within the United Kingdom." The whole purport of the legislation was the benefit of the public by *inter alia* reducing the expense of telegrams. The matter now in dispute was whether the apparatus employed by the defendants were telegraphs, and whether they transmitted or aided in the transmission of telegrams. This would require an investigation into what were "telegraphs" and "telegrams." It was remarkable that the definition in the Act of 1853 did not in any way refer to electricity, though it clearly, by its reference to posts and wires, included it. It was also remarkable that the later definition omitted all reference to wires, and makes "electric signals" the defining words. This was probably due to the fact that at that time there was talk of effecting direct communication through water. He then cited the exceptions from the monopoly given by sec. 5 (*see* Information), and argued that the defendants could not be brought within them, as they transmitted messages for gain. If he understood the defences that would be set up, they were (1) That the wires, posts, and apparatus of the Company are not "telegraphs" within the meaning of the Act; (2) that they come within the exceptions of sec. 5; (3) that the messages of the Company are also within the exceptions; (4) that the Company does not in fact send messages. The case he should put forward on the part of the Crown was this. Upwards of ten millions of public money had been spent in acquiring a privilege. What was the privilege which was obtained at so heavy a price? It could be and was nothing less than the exclusive right of conveying all messages by wire or other means for hire. If it could be shown that the defendants had transmitted messages by means of electric agency, they would be clearly within the terms of the Act, and the Crown would be entitled to recover. The defendants would say that the telephone could not be a telegraph within the meaning of the Act, as it was wholly unknown at the time when the Act passed. Such a contention could not be supported. If it could be the invention of railways would have overthrown a letter-carrying monopoly, instituted at the time when stage-coaches conveyed the mails, or the invention of the pneumatic despatch, the monopoly enjoyed in later times. The result of such an argument would be that each new telegraphic instrument, as it was invented, would deprive the Post Office of its monopoly. The legal authorities were clear upon the point. It had been held that words originally intended to apply to roads could apply to railroads. There was no desire on the part of the Crown to check invention; he most emphatically disclaimed that. Inventors and companies would always be dealt with in a liberal spirit if they consented to become licensees of the Crown; but the public interests must be protected, and those who infringed a monopoly created for a public benefit must be proceeded against. Turning to the meaning of the word telegraph, he said that there was an idea in the minds of some persons that a telephone could not be a telegraph, because the word *graph* implied writing; that, of course, was absurd. One had only to consider the earliest form of telegraph, the semaphore, to be disabused of such a notion. Telegraphs were of various kinds; there was the heliograph, and the nautical and military flag systems were telegraphic. In the affidavit of Mr. R. Sabine, a reference was given to the invention of telegraphs by Amontons in 1663. Sir W. Thomson, in the "Encyclopædia Britannica" of 1860, defines "telegraphic communication simply as the interchange of ideas between two intelligent beings by means of inanimate matter occupying space between them," though no doubt, in his affidavit on the part of the defendants, he now disclaims his definition, and says it is too wide.

Sir J. STEPHEN.—All this is no doubt very interesting, but is it to the point? I have carefully read through the affidavits, and it must be remarked that they are made by scientific men who are accustomed to make matters interesting to the public, and do not advance the question here, which is solely what is the meaning to be assigned to the words "telegraph" and "telegram" *as used in these Acts of Parliament;* of that we are the judges, not they.

The ATTORNEY-GENERAL said it would be necessary to consider what telegraphs were in use at the time of the passing of the Act of 1869; what progress was made up to the date of invention of the telephone; and what had been done subsequently. The defendants said the telephone was not an electric telegraph, but he should demonstrate that the three essential factors of a telegraph, viz., current, conductor, and means of varying the strength of current, were also the essential factors of telephonic apparatus, which, with all its great beauty, was only a very refined means of doing that which had been done somewhat coarsely before, viz., varying the strength of an electric current, and demonstrating the existence of the variation. Such an improvement could not deprive the Crown of a monopoly.

Sir J. STEPHEN.—It is clear that the Crown and the defendants both employ your three factors. The question will be whether the way they are employed is not totally different in the two cases.

Sir HENRY JAMES then proceeded to consider the various constituents of an electric telegraph. Pointing out that in all electric telegraphs there must be a curren

which might be generated by various means, he showed that in order that the current might be available for telegraphic purposes there must be some means of varying its strength; this might be done either by causing it to be intermittent or by gradual and continuous variation. The operator appealed to the senses of the receiver by these variations, and thus telegraphed to him. The senses appealed to might be any one of the five. Originally in the needle telegraph the sense of sight was appealed to. If the Crown had then been in possession of the monopoly, would it have lost it when Bright's telegraph, which worked with two bells, and, moreover, by magnetic currents without a battery, was brought out? The telegraph most in use by the Post Office was Morse's. That worked by variations of current strength, which were demonstrated by long and short ticks of the receiving instrument.

Mr. BENJAMIN.—It does not work by variation, but by interruption. It is a very different thing.

The ATTORNEY-GENERAL.—The question is one purely of degree. If the defendants were going to rely on the difference between interruption and variation they would fail, as Sir W. Thomson in 1858 in his syphon recorder, and Mr. Varley in 1862, both employed variable currents, as their patents would show; the latter expressly says, in his patent No. 3543, that he works "by the increment and decrement of electric currents."

Mr. BENJAMIN.—I confined my remark to the Morse instrument, which you were demonstrating.

The ATTORNEY-GENERAL.—The Morse instrument communicates ideas by what is termed a conventional code. To those who operate the code is no more conventional than language is to most people. Language is merely not conventional because it is known to a number of people. If it be said that with a telephone you can tell who is speaking, it may be replied that a Morse operator can tell who is communicating with him. It is said that the telephone differs entirely from the instruments that preceded it. To demonstrate that this was not so, the Attorney-General first showed that by rapidly breaking contact at the transmitting end, a continuous note, varying in pitch, could be produced at the receiving end. A combination of such notes, by means of Stroh's vowel sounder, was shown to produce vowels, and Stroh's siren was made to say "papa." This led up to Edison's phonograph, the action of which was stated to be similar to that of the telephone, as to which it was then said it was impossible that the Court could say that it was so different from anything that preceded it that the monopoly of the Postmaster extended up to the time of its invention, and then ceased. The great diversity of instruments employed in telegraphy was illustrated by reference to Wheatstone's automatic transmitter, Hughes' printing telegraph, the writing telegraphs of Bonelli, Arlincourt, and Cowper, as to the last of which it was stated that it worked by variation and not by interruption, Mr. Justice Stephen remarking that it was the first real telegraph that had been shown or mentioned to them. Turning to the telephone, the Attorney-General said, that as pointed out in the Information, Mr. Edison himself called it a telegraph. As to the statement in the "Answer," that before 1869 no human being knew of or dreamed of the telephone, that was not true. In the "Exposé des Applications d'Electricité," par le Viscomte du Moncel, Paris, 1857, the following views of M. Charles Bourseul are quoted:—"I ask myself, for example, if speech itself could be transmitted by electricity, in a word, if one could not speak at Vienna and make oneself heard at Paris. The thing is practicable, and thus . . . . I imagine that one speaks near to a mobile plate sufficiently flexible not to lose any of the vibrations produced by the voice, that such plate establishes and breaks successively communication with a pile. You can have at a distance another plate, which will execute at the same time the same vibrations. It is true that the intensity of the sounds produced will be variable at the point of departure where the plate vibrates by the voice and constant at the point of arrival, where it will vibrate by electricity. But it is shown that this cannot alter the sounds . . . . Any one who is not deaf and dumb could make use of this mode of transmission, such would not require any sort of apparatus. Any electric pile, two vibrating plates, and a metal wire would suffice." Again, the well-known invention of Reis, upon which the telephone is based, was invented in 1860.

The COURT.—It is really immaterial when the telephone was invented. The question is, Is it a telegraph within the Act?

The ATTORNEY-GENERAL then proceeded to deal with the mode of carrying on the business of the Company, pointing out that it was impossible in the face of the trunk lines, which unquestionably belonged to the Company, and of the switch-boy, who undoubtedly aided in the transmission of messages, to say that the Company did not come within the Act. In conclusion, he remarked that if the operations of the Company were extended the danger to the revenue would be a very serious one.

The evidence in the case was then gone into. This, according to practice, was in the form of printed affidavits, the witnesses being in court to be cross-examined if desired. Much of the evidence went to establish the statements in the pleadings, and much of it consisted of the opinions of scientific men of eminence as to what, in their opinion, constituted a telegraph. This, as will have been seen, was considered by the Court to be irrelevant. We shall give short extracts from the affidavits on such points as seem of interest.

Mr. E. GRAVES, the engineer-in-chief of the Post Office Telegraphs, says: "It is my undoubted opinion that every apparatus for communicating intelligence from one place to another at a distance from it, by means of the passage of currents of electricity along a wire or wires between such places, is an electric telegraph, as I have for the last twenty-seven years understood the expression." He gives the following list of the various instruments in use by the Post Office on March 31st, 1879:—

Printers.—	Morse	1324
	Automatic	151
	Hughes	6
Acoustic.—	Morse	1572
	Quadruplex	10
	Bell's	260
Visual.—	Needle	3541
	A B C	4916
Miscellaneous	... ...	242
Telephones	... ...	22

He quotes from the "Encyclopædia Britannica" of 1860, the following words of Sir W. Thomson as to a "telegraph": "The term has been from the beginning, and is constantly still applied to apparatus for communicating intelligence to a distance in unwritten signs, interpretable by an intelligent being from their effects perceived through his senses of sight or of sound, and has, in fact, only recently had application to those wonderful combinations of inanimate matter which literally write at a distance the intelligence committed to them. We may, therefore, define telegraphic communication simply as the interchange of ideas between two intelligent beings by means of inanimate matter occupying space between them."

Mr. W. H. PREECE gives a very full description of the instruments employed in telegraphy. He also quotes a definition of a "telegraph" from Nichol's "Cyclopædia of the Physical Sciences" of 1857: "A telegraph is an instrument used for the purpose of conveying intelligence to a greater distance than the sound of the voice can reach without a messenger."

Mr. ROBERT SABINE gives a number of definitions of telegraphs from a variety of books of all dates.

Mr. VARLEY relates how he purchased a pair of Reis's instruments in 1862, and made various experiments with them. When a tune was sung into the transmitter the effect at the receiving instrument "was much as if the tune was sung by a gruff voice." He considers that the tunes were "telegraphed from one instrument to the other.",

Mr. LADD gives an account of how he came across Reis's instrument at an instrument maker's in Friedrichsdorf, and sets out a letter he received from Reis on the subject, dated July 13th, 1863, in which it is said that "Any sound will be reproduced if strong enough to set the membrane in motion."

Sir CHARLES BRIGHT say that in telephony "no sounds whatever pass from the sending station to the receiving station. Nothing passes between the two stations except impulses, or currents of electricity;" and that it is his "deliberate opinion that the wires and apparatus of the defendant Company are telegraphs."

Mr. LATIMER-CLARK is of opinion "that the wires and apparatus of the defendants are to all intents and purposes telegraphs." He considers "the facts that the mechanical agency of the voice of the sender of the message is used to set electrical force in action, and that the sounds produced at the receiving station resemble the words uttered at the sending station are not material to the question of whether the apparatus is a telegraph. Between the sending and receiving stations there is or are a wire or wires in electrical connection; and when a message is transmitted by means of that wire or those wires, nothing passes from one station to the other but currents or waves of electricity, which are used to communicate intelligence from the sending station to the receiving station."

Mr. D. E. HUGHES says that telephones "are, in truth, only new kinds of transmitting and receiving instruments."

Mr. BARLOW states that "the word 'language,' although originally applied to some action of the tongue, is often used as including any means of conveying thought or intelligible meaning by sight or sound. All telegraph instruments now employed in this country for the transmission of intelligence by electrical agency between distant places, convey language or intelligible meaning received either by sight or by marks or by sound. In all the means employed in electric telegraphy one common principle is involved. They all convey their language or intelligence by a species of articulation made by alternate actions and cessations of actions of more or less duration. And I say that in all the instruments employed in transmitting intelligence by electricity, whether the action or effect is conveyed to the receiver by sight or by sound or by marks, it is the articulation thus given to the language which renders it intelligible." He further states that his well-known invention, the "Logograph," proves "that the articulations of the human voice, although it is accompanied by varying vowel sounds, is, like that of the telegraph instruments, made by certain relations in the duration and cessation of action."

Dr. WARREN DE LA RUE is of opinion that "an electric telegraph may be defined as an apparatus so constructed that by means of a series of electric currents or impulses transmitted at intervals through or along a wire or wires, from one station to another station at a distance, a series of corresponding impulses is produced at the distant station."

On the part of the defendants, the Right Hon. E. P. BOUVERIE, the Chairman of the Company, and Mr. ARNOLD HENRY WHITE, the Secretary, testify to the truth of that part of the "Answer" which relates to the mode in which the Company carry on business.

Sir W. THOMSON states that at the time he wrote the paragraph referred to in the affidavit of Mr. Graves, he "had not the slightest idea that an electric telegraph wire could be used for the transmission of speech;" and he considers that the telephone cannot be correctly described as a telegraph within the Acts of 1863, 1868, and 1869, "which I have read." He further says, "I cannot conceive it to be possible that so entirely novel an application of electrical science as these instruments involve can be considered to have been included in the monopoly which Parliament gave to the Post Office Department. When the Telegraph Acts were passed the telephone had not been invented, and no one concerned in that legislation had the slightest idea, nor had any one living the slightest idea, that it would be possible so to extend the power of speech as to enable persons at a distance to converse with one another. Previously to the invention of the Bell and Edison telephones, the only mode of communicating between two persons at a distance was by personal messages or by writing, or by the use of some previously arranged code of signals, or by voice tubes. The musical toy invented by Reis about the year 1860 was not in any sense a speaking telephone, nor could it transmit articulate speech."

Professor G. G. STOKES states that the telephones of Bell and Edison "are entirely novel inventions, and are based upon new applications of electrical science of the greatest interest and importance. There is no real similarity between the speaking telephone and the various instruments used for telegraphic communication, except that both require the agency of electricity, and therefore a battery, or magnet, and a wire to conduct the current is essential to both. Neither the transmitter nor the receiver of the telephone in any way resembles in their mode of operation the corresponding parts of a telegraphic instrument; and if a single word is to be used to include both a telephone and a telegraph, it must, in my opinion, be wide enough to cover every instrument which may ever be invented which employs electricity transmitted by a wire as a means for conveying information. I draw the broadest possible distinction in my own mind between mere improvements in the mode of sending and receiving a preconcerted code of signals, and a discovery of so totally novel and unexpected a character and so different in its results as that of the telephone."

Professor TYNDALL says: "I have never on any previous occasion expressed an opinion in any legal proceedings on questions affecting the application of science to the uses of life, and I have always steadfastly declined to do so when requested; but, having explained the principles and illustrated the action of the telephones of Mr. Graham Bell and Mr. T. A. Edison in the lecture theatre of the Royal Institution, I am desirous that my silence should not be misinterpreted, and I have, therefore, on this occasion consented to express the opinions hereinafter contained. Comparing, in the first place, the ordinary telegraph with the scientific results achieved before that telegraph became a patented invention, and comparing, in the second

place, the telephones of Bell and Edison with the existing telegraph, the advance as regards novelty and originality is, in my opinion, vastly greater in the second case than in the first. The one was a difference of degree, the other is a difference of kind. Prior to the labours of Bell and of Edison it had never, to my knowledge, entered into the thoughts of scientific men to transmit by means of electricity the tremors of the human voice, so as to reproduce audible and articulate speech at a distance. The proof that this was not only possible but practical appeared to those most familiar with experimental physics to be an application of electrical and acoustical science not only new but marvellous. I have, therefore, no hesitation in expressing the opinion that to confound the telephone with the telegraph would be to place in the same category utterly dissimilar things."

Dr. GLADSTONE considers that a telegraph is a "mode of communicating intelligence to a distance greater than the human voice will naturally reach, by means of a code of arbitrary signals previously agreed upon." He also considers that a telephone is not a telegraph, but "involves an entirely novel application of electrical science," and is "distinct in principle from all previous applications of electricity to the transmission of intelligence."

Professor CAREY FOSTER considers that the "words 'telegraph' and 'telegraphic communication,' which I find used in the Telegraph Acts, must mean such forms of instrument and such methods of communication as were known and used at the date of the Acts, with such further inventions as may fairly be considered as modifications or improvements of these." He asserts that no essentially new principle is involved in Reis's invention, but that the telephone "depends upon two distinct discoveries, one relating to the communication of vibrations between solid bodies and the air, the other to the employment of the vibrations excited in solid bodies by sound waves to cause periodic variations in the strength of electric currents. I am satisfied that before the invention of the speaking telephone no one knew, and few physicists would have believed, that the same solid body was capable of taking up from the air all the countless and minute varieties of vibratory motion which are concerned in the production of articulate speech. Again, no one knew that, even if it were possible, to cause the strength of an electric current to vary periodically at one part of a long conducting circuit in a manner corresponding with the vibrations of articulate speech, these minute variations would still be sufficiently perceptible at a distant point, and retain in a sufficient degree their individual character to make it possible to produce by means of them at that point audible vibrations exactly corresponding to those by which they had themselves been produced at the first point."

Dr. FLEMING says: "In Reis's instrument there was no intermediate stage between current on and current off, no graduation of current, and, therefore, no possibility of transmitting a current whose strength varied with the variation of air-pressure. This instrument had no claim to be called a telephone in the sense of a speech transmitter, inasmuch as it never did and never could transmit the infinitely more complicated waveforms of speech." He continues: "In my opinion the Edison telephone may be properly described as an apparatus by which one person causes the air at a distant station to vibrate in an exactly similar manner to that in which it vibrates close to his mouth, and this is what happens in ordinary speech." "In a telegraph, as ordinarily understood, the idea of a signal is an integral part of the notion; and, apart from a recognised code and a pair of trained observers at either end, the electric telegraph is of no practical use to the public." He also remarks: "When I, standing in one closed room, shout to another person in an adjoining room, the waves of sound from my voice beat against the wall, transmit their motion to the particles of the wall, and these, again, hand on the motion to the air in the other room. In this case the molecules of the wall constitute an apparatus by which motion of the air in one place is repeated in another. The Edison telephone does just the same thing."

Baron JULIUS DE REUTER says that, if in 1869, he had believed the telephone "to be within the limits of practical science, and had desired to describe it," he should "certainly not have used the word 'telegraph.'"

Mr. SYMINGTON of Glasgow describes the A B C exchange as worked by him in that city, and states that although the Post Office threatened him with proceedings in 1875, they never followed the matter up.

Affidavits on the part of the Crown were read in reply to these.

Sir CHARLES BRIGHT, in reply to Sir W. Thomson, says that in 1868 he was a member of Parliament for Greenwich, and had at that time read the Viscomte du Moncel's book, and had considered the possibility of carrying out the idea of M. Charles Bourseul.

The ASTRONOMER ROYAL and Professor ADAMS say that no identity between aerial vibrations and electric currents can be reasonably said to exist, as we know nothing of the laws governing the operations of electric impulses. They say also that no conclusion can be drawn from any supposed identity of the mathematical expressions for such vibrations and currents. The meaning of any particular expression in mathematics depends on the meanings assigned to the symbols, which may be various and utterly dissimilar.

Dr. C. W. SIEMENS considers that telephones are telegraphs.

Mr. S. M. YEATES of Dublin describes experiments made by him with Reis's instruments. He greatly improved on it, and in 1865 succeeded in transmitting the sound of the voice so that the voice of the person sending the sound could be recognised.

Mr. SPOTTISWOODE, the President of the Royal Society, without expressing any opinion as to the proper construction to be put upon the word "telegraph," as used in the Telegraph Acts, is personally of opinion that the telephonic apparatus is merely a new form of transmitting and receiving telegraphic apparatus.

Affidavits were then read on the part of the defendants.

Lord RAYLEIGH, the Professor of Experimental Physics in the University of Cambridge, asserts that telegraphy involves a code of signals; that the telephone is not a telegraph, but is "an instrument for artificially extending, by the use of electricity, the limits through which the human voice is audible." "The only essential difference between a speaking telephone and a speaking tube is, that in the former vibrations are transmitted in the electrical, in the latter in the aerial form."

Dr. HOPKINSON considers that "It is essential to the idea of a telegraph, or to the idea of signalling, that signs, other than the articulate speech which we or others learn in infancy, should be the mode of communication. The electrical vibrations in a conducting wire, which occur when words are spoken into or heard from a telephone, do not imply electric or any other sort of telegraphy. Whatever may be the ultimate nature of these electrical vibrations, they certainly have the characteristic that they correspond in every

particular with, and are in form similar to, the vibrations of ordinary matter when transmitting the same sounds. Indeed, the mathematical expression of the electric current at any point of the telephone wire is the same as the mathematical expression of the movement of the air at any point outside the telephone. Without straining the use of the words, we may say that the currents in the telephone wire transmit sound in the same sense that the movements in the air around us transmit sound. In the case of writing telegraphs and printing telegraphs the case is very different; the electrical states of the wire have no similarity to or other than a wholly conventional and artificial correspondence with the written or printed character."

At the conclusion of the reading of the evidence it was agreed between the learned counsel on both sides that there should be no cross-examination of the witnesses, who were thereupon released from further attendance.

(To be continued.)

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XXIII.

The Wheatstone Automatic System.

This important instrument is now very largely used in the United Kingdom for the transmission of ordinary and press message work over the main trunk wires, and also at race meetings where a large amount of work is required to be done in a short time; indeed, without the help of the Wheatstone instrument it would be impossible to transmit, without heavy delays, the large amount of work which has daily to be carried on. At the present time over 170 automatic instruments are in daily use, working up to a speed, in some cases, of 200 words a minute. At present this rate of working is found sufficient for all purposes, but there is but little doubt that a much higher speed can be obtained if necessary; indeed, a speed of 250 words has actually been obtained between London and Glasgow with the existing form of apparatus.

The Wheatstone apparatus consists of three parts, viz.: the *puncher*, the *transmitter*, and the *receiver*. The former is employed for preparing a slip of paper for transmission through the transmitter, and it is worked either by direct blows or by pneumatic action controlled by finger keys.

To understand thoroughly the action of the apparatus it will be convenient to consider first its general principle.

Fig 86. represents a facsimile of the punched paper strip for the transmitter, and the corresponding slip with the recorded signals as it passes out of the receiver.

On the punched paper strip there are three rows of holes; the holes in the centre row are equidistant, and are for the purpose of enabling the paper slip to be drawn forward at a uniform rate through the transmitter. For this purpose the latter is provided with a small star wheel turned by the clockwork, the teeth of this wheel gear into the perforations in the slip, and draw the latter forward by a rack and pinion movement.

The upper and lower sets of perforations, which are rather larger than the middle row, are for the purpose of controlling the currents sent out by the transmitter.

Figs. 87, 88, 89, represent the controlling mechanism in the transmitter.

C, Z, are two bell-crank levers, pivotted at the angles and connected to the zinc and copper poles respectively of the battery. The spiral springs, s_6, s_6, made of stiff brass wire, tend normally to pull the two longer ends of the levers together; the inside part of these ends are faced with platinum and between them are two platinum pins, p_3, p_4, fixed to the disc, D.

Referring to fig. 88, it will be seen that if the two platinum faced ends of the levers could both rest at the same time against one or other of the pins, p_3, p_4, that the battery would be short-circuited; this is prevented by means of a small screw, *a*, which is screwed through the end of the lever, C, and whose end touches against a small piece of ebonite, *e*, fixed in the end of the lower lever, Z. The screw, *a*, is so adjusted that the distance between the two platinum faces is rather greater than the diameter of either of the pins, p_3, p_4, thus the circuit of the battery cannot be closed through either of the pins.

The disc, D, is divided into two halves insulated from each other, so that the pin, p_3, is insulated from the pin, p_4. The disc is axled behind at its centre so that it can rotate through a small angle to the left or right as required. A steel tail piece projects from the top and bottom of the disc, and against the top one a jockey wheel, E, set at the end of a spring, presses; the object of this wheel is to keep the disc firmly in either of the two extreme positions it may assume—that is to say, with the top tail piece against either the left or right-hand stops between which it plays.

It will be noticed that when the disc is in the position shown in fig. 87 that the copper pole of the battery is connected to the pin, p_4, and the zinc pole to the pin, p_3. When the disc is rotated until the top tail piece comes over against the left-hand stop pin, as shown in fig. 89, then the zinc pole is connected to pin, p_4, and the copper pole to pin, p_3; thus the right and left-hand movement of D reverses the battery relative to the pins, p_3 and p_4, that is, relative to the two insulated halves of D. The "Up" line being connected to the right-hand half of the disc, the rocking of the latter connects the zinc and copper poles alternately to it.

Y is an ebonite beam which is caused to rock at its centre by means of the train of clockwork which drives the star wheel before referred to. This beam is provided with two platinum studs or pins, p_1, p_2, the left-hand one of which is connected permanently to the "Down" line. These two pins normally press against two bell-crank levers, A, B; the horizontal arms of these levers are pulled upwards by means of the springs, s_3, s_4.

The levers being hinged directly on to the frame of the apparatus are in electrical contact with one another.

To the crank, A, a rod, H, is hinged, whose end passes through a hole in the tail piece, P. A small collet, K[1], is screwed on to H, which, when H is moved to the right by the action of the crank, A, presses against the tail piece, P, and rotates the

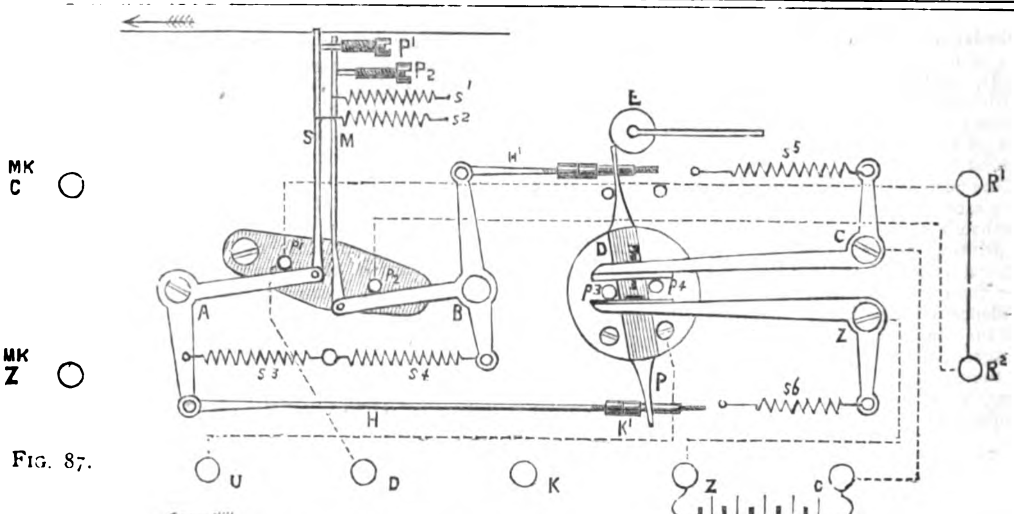


FIG. 87.

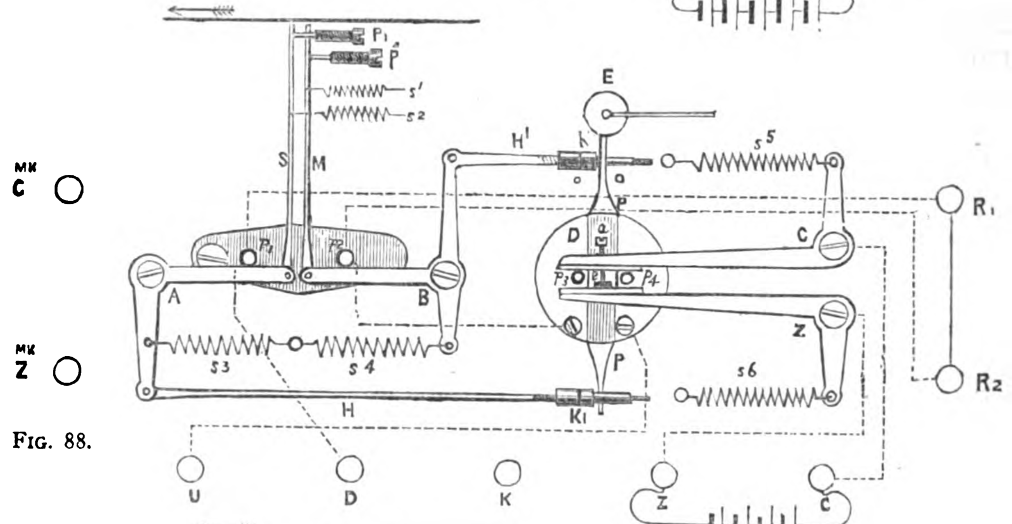


FIG. 88.

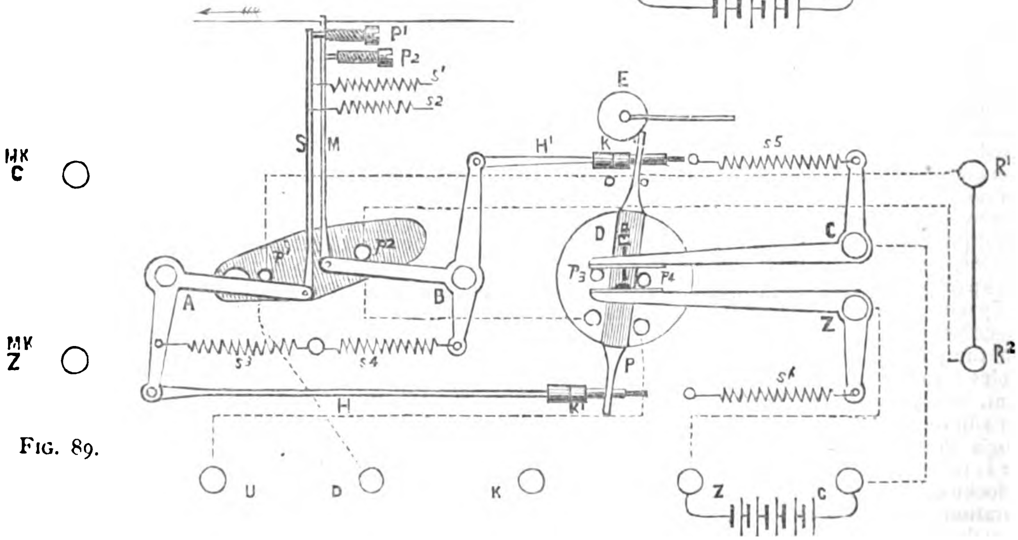


FIG. 89.

disc, D, over to position shown in fig. 87. Similarly, the collet, K, on the rod, H^1, can press against the top tail piece, and throw the disc, D, over to the position indicated in fig. 89.

The collets, K, K^1, can be adjusted by being screwed forward or backward; their correct position is such that when the parts are in the position indicated by fig. 88, K nearly touches the upper tail piece and K^1 nearly touches P.

Besides the connections already referred to, it will be noticed that the right-hand pin, p_2, on the beam, Y, is connected to the left-hand half of the disc, D.* The two pins on the beam, Y, are also connected to two terminals, R_1, R_2, which, as a rule, are short-circuited by a brass strap.

Supposing now the beam, Y, is caused to rock by the clockwork connected to it being allowed to run, then the pins, p_1, p_2, on the beam will alternately depress the crank levers, A and B, and the motions of the two latter, through the medium of the rods, H, H^1, will cause the disc, D, to rock in unison. As has previously been explained, the latter motion will cause the copper and zinc poles of the battery to be alternately connected to the "Up" line. Now, S, came against an obstruction, then the spring, s_3, would be unable to pull the crank lever, A, so as to keep it against the left-hand pin, p_1, of the beam, Y. Although, therefore, the latter would have come to the position shown in fig. 89, yet, since the crank lever, A, did not follow it, the disc, D, would still be left in the position shown in fig. 87, that is to say, a copper current would continue to flow to the "Up" line, and a zinc current to the "Down" line. Similarly, if the disc, D, had been rotated over to the left, as in fig. 87, so that the direction of the current was the reverse of that previously indicated, and the rod, M, had been prevented from rising, then, on the beam, Y, rocking back to the position shown in fig. 89, the spring, s_4, on the crank piece, B, would be unable to pull the latter so as to move the disc, D, over again to the right, and consequently the current would remain unreversed.

Suppose, now, the paper slip represented by fig. 86 be passed from right to left over the ends of the rods, S, M, then these rods, being set at a distance apart equal to the distance between the rows of holes on either side of the centre row of perforations on the paper slip, will in succession pass

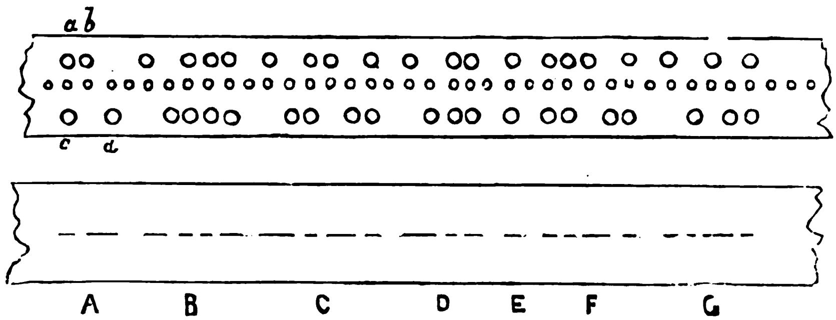


Fig. 86.

the pin, p_3, on the disc, D, being in connection with the right-hand pin, p_2, on the rocking beam, and also, through the terminals, R_1, R_2, with the left-hand pin, p_1, and the "Down" line, it will be evident that when p_3 touches the end of lever Z, and p_4 touches the end of lever C, as in fig. 87, that a copper current will flow to the "Up" line, and a zinc current to the "Down" line; also, when the position of the disc, D, is that shown in fig. 89, then a zinc current will flow to "Up" line and a copper current to "Down" line. Thus, by the continual rocking of the beam, Y, positive and negative currents will be alternately sent out to the "Up" and "Down" lines.

At the ends of the crank levers, A, B, are pivotted two steel rods, S, M. Now, supposing the whole mechanism to be in the position indicated in fig. 87, then a copper current will be flowing out to the "Up" line and a zinc current to "Down" line. Next, suppose that the beam, Y, commences to rock over to the position shown in fig. 89. Now, if the whole of the moving parts were free to move, then, as has been explained, the disc, D, would be rotated until the top tail piece comes over against its right-hand stop pin; but if the end of the rod, through these holes, and thereby allow the disc, D, to be thrown over in one direction or the other, according as the rod, S, or the rod, M, passes through a hole.

Assuming the mechanism to be in the position indicated by fig. 88, let us imagine the slip represented by fig. 86 to be in such a position that the end of the rod, M, is under the hole, *a*. When the mechanism is set in motion, the rod, M, will pass through this hole, *a*, unobstructed, and consequently the disc, D, will rotate over to the position shown in fig. 89, and a current in one direction will pass out to the line. As the mechanism continues to move, the paper slip moves forward by means of the star wheel before referred to, and when it has gone sufficiently forward the rod, S, enters the lower hole, *c*, on the slip, and the disc, D, becomes rotated over to the left, and thus the current becomes reversed. As the slip moves forward again, the rod, M, enters the second top hole, *b*, of the slip, and again the current becomes reversed; when, however, the rod, S, again rises, the second lower hole, *d*, on the slip being behind the top hole, *b*, last referred to, does not come forward in time to allow S to pass through it, consequently the disc, D, cannot be rotated, and the current remains unre-

* This connection has been accidentally omitted in fig. 87.

versed. Again, when the rod, M, in turn rises, it has no perforation to pass through, and so the disc, D, still remains unaffected; when, however, the rod, S, rises for the third time, it has now the hole, *d*, to pass through, and consequently the disc, D, can be rotated and the current reversed In one case, then, we have a current, followed almost immediately by a reversal, and in the second case, a current followed after an interval by a reversal. These currents being received on a polarised relay, as in the ordinary double current system, it is obvious that a dot and dash would be produced.

Notes.

THE JAMIN LIGHT.—Probably before the end of this week the first important exhibition of the Jamin light in London will have taken place. As we have previously stated, Messrs. Samuel Brothers are to have their new building illuminated by that system. The lamp is almost precisely similar to that described in our issue of July 1st of this year. There are, however, two slight alterations in its use: one is that the weight of the movable carbons is nearly counterpoised, and secondly, that instead of the spring arrangement for pushing one of the used-up carbons out of the plane of the horseshoe and then out of circuit, a very simple and ingenious method is adopted for effecting the latter purpose. A brass L-piece with a screw of the same metal is placed in close proximity to one of each pair of carbons. When the arc reaches this screw the current is short-circuited, the armature falls, and the carbons of the other candles being brought together, the arc is instantly re-established at the point of least resistance.

MR. GORDON'S LAMP.—Experiments are, we understand, still being continued with this lamp, as described in our last issue. It has, we believe, been found that after two or three weeks' use there is a palpable deposit, on the containing vessel, of the metal used for the small ball electrodes. As the costly metal iridium had been found the most advantageous generally, for these electrodes, it became necessary that the deposit should, to render the lamp sufficiently economical for ordinary use, be recoverable. Trying this in a somewhat primitive or rough fashion, the inventor has succeeded in achieving success to the extent of about three-fourths of the whole loss by combustion. We have been asked by some of our readers if with this lamp there is not a noise, but we hear that when the metal balls are once properly adjusted—that is, as close as possible without contact—there is no noise whatever to be noticed. Unlike the ordinary incandescence lamps, which cool rapidly, and therefore show every variation of the current, this lamp gives a most steady light, notwithstanding slightly unequal speed of the machine or engine. This is doubtless to be accounted for by the fact that the loss of heat in the inner balls is made up by a rush of heat from the outer balls, and also from the slower cooling properties of iridium over those of carbon.

THE HARMONIC TELEGRAPH.—On a Boston line it has been found possible to send simultaneously by one wire, and analyse at the other end, four distinct tones, thereby transmitting four separate messages in one direction at one time. This offers a signal advantage over the quadruplex system, which transmits two separate messages simultaneously each way, but cannot send four messages one way. In cases of extraordinary pressure of business the full capacity of the harmonic system may be utilised in either direction. It is hoped that the harmonic system will ultimately make possible the simultaneous sending of four or five messages both ways on a single wire; in other words, four tone messages and one ordinary Morse message in each direction, or ten in all. In this way all the tones of the octave will be made use of, and that is the probable limit of the system, unless it be found possible to operate with fractional tones.—*Scientific American.*

THE first number of a periodical, devoted to the subject of instruments, will be issued January 1, 1881. It will be published in Berlin under the name of the "Zeitschrift für Instrumentenkunde," and will be prepared by a board of twenty-one editors, including the most noted instrument makers of Europe and representatives of different branches of science in which instruments of precision are employed. Such a periodical is greatly needed, and the names of the editors are a guarantee of its success.—"O. S." in *Science.*

WERDERMANN *v.* SOCIÉTÉ GENÉRALE D'ELECTRICITÉ.—This was a motion, on Friday, the 10th, before Vice-Chancellor Bacon, on behalf of the plaintiff, for the usual preliminary order for accounts and for an injunction to restrain the defendants from selling or disposing of the patent well known as the Jablochkoff system of electric lighting, in which the plaintiff had a joint interest, and of which he claimed to be the inventor. After a long argument his lordship granted an injunction in the terms prayed.

NEW ARRANGEMENT OF THE MAGNETS OF A GALVANOMETER. K. Schering.—The multiplier contains a hollow space 532 m.m. long, 5·5 high, and 72 m.m. wide. It can be set with its length horizontally when a single magnet is suspended in it, and set vertically when thirty cylindrical magnets of 50 m.m. in length and 10 m.m. in diameter, fixed over each other to an axis, have room to play. The angle of deviation is then 3·7 times as large as in the horizontal position.—*Göttingen Nachrichten*, 1880, 455-457.

ELECTRIC LIGHT AT BRIGHTON.—Brighton is about to prove the practicability of electricity for street lighting purposes by illuminating the Grand Parade therewith.

THE ANGLO-AMERICAN ELECTRIC LIGHT CORPORATION (LIMITED.)—The prospectus of the Anglo-American Electric Light Corporation (Limited), of 74, Hatton-garden, and Victoria Works, Lambeth, has just been issued. It is formed for the purpose of taking over the business and extending the operations of the Anglo-American Electric Light Company (Limited.) The capital is to be £800,000 in 80,000 shares of £10 each, only half the number of shares will be included in the first issue. £1 is to be paid on application, and £3 on allotment. It is stated that the profits of the Corporation will arise from (1) the manufacture and sale of dymano-machines and lamps, and the sale of carbons; (2) the sale of continental, colonial, and other patent-rights; (3) the letting-out of lights worked from central positions; (4) contracts with corporations and other public bodies, and with private firms and individuals. For further particulars, see advertisement, page ix.

A METHOD OF PRODUCING THE ANOMALOUS MAGNETISM OF STEEL BY MEANS OF THE CURRENT OF A BATTERY. Bartoli and Alessandro.—The anomalous magnetisation of steel, first recognised in 1863 by Waltenhofen, and repeatedly observed by Righi, has been confirmed by the authors, who used a Daniells' and six Bunsen elements. With twenty elements the magnetisation was merely normal. If on opening the magnetising current the spark was avoided, no anomalous magnetisation was obtained with from one to twenty Bunsen elements.—*N. Cim.*, viii., p. 16.

The French Government, on the 10th inst., laid on the table of the Chamber a demand for a grant of three hundred thousand francs in favour of the International Electricity Exhibition and Congress. The Government points to the patriotic sentiments with which the subscribers of the guarantee fund are animated, and begs the Chamber to participate in a work which must prove most valuable to the advancement of a science which has lately made such rapid strides, and which promises to render such great additional services to the whole civilised world. One hundred and fifty thousand francs are applied for in favour of the exhibition itself, but the Government, wishing to keep the direction of the Congress in its own hands, asks for another one hundred and fifty thousand francs to cover all expenses.

The Great Eastern Railway Company have decided to fit one at least of their Continental steamers with the electric light.

A Contribution to the Analysis of Electric Discharges. W. Holtz.—The electrodes (tin-foil points) between which the sparks of an induction apparatus were striking were made to revolve up to 100 times per second on an ebonite disc of 12 c.m. diameter. When the distance traversed by the sparks is very small the extension of their image is greatest. It is reduced by decreasing the number of the exciting elements and the number of the iron wires in the inductive coil, or by increasing the resistance of the air. The image consists of a great number of parts separated by intervals, and has a short, bright anterior end, followed by a dark violet train, differing in length. On connecting the poles of the induction apparatus with Leyden jars, the larger the jars the more the total extent of the image of the spark and of its parts is shortened; the violet trains disappear, and the heads become brighter. This shows that the intermittent luminous phenomenon does not depend on an intermittent excitement of electricity within the coil, but merely on an intermittent discharge of its end-surfaces: for with the increase of the polar surfaces, and with prolongation of the distance traversed by the sparks, the quantity of electricity of the several discharges is increased at the cost of their number. Exactly similar phenomena are observed on discharging Leyden jars with the intercalation of moist cards when the ends of the cards are connected each with a smaller Leyden jar just before the track of the sparks. The length of the entire image increases with the size of the surface of the battery.—*Göttingen Nachrichten*, ix., p. 345.

M. Somzée, a Belgian engineer, proposes to utilise the safety lamp for revealing the presence of fire-damp in collieries. It is well known that the flame of the lamp elongates and acquires a higher calorific power when in air which contains light carburetted hydrogen, or marsh gas. A piece of metal is so placed as to be elongated by this flame; this produces electric contact, and causes a bell to ring. Several of these lamps should be placed in different parts of the mine, and the bells numbered.

One of the dials of the Westminster clock is to be illuminated by the electric light on the Brush system.

New Electric Dust-Figures as a Contribution to the Explanation of the Phenomena in Geissler Tubes, and to the Refutation of the Hypothesis of Crookes. Yvon Zoch.—Tubes of 10—30 c.m. in length and 1—3 c.m. in width were closed at each end with corks, through which were passed copper wires. Bronze-powder was introduced: other lighter powders which were tried adhered to the sides of the tube under the influence of the discharge in consequence of static charges. One wire was connected with the positive conductor of an electric machine, whilst the other permitted the supply of electricity to escape into the air. In certain cases the electricity was furnished by a charged Leyden jar, and the pressure of the air was that of the atmosphere. The bronze-powder displayed then very beautiful stratifications, which differed in their arrangement according to the original position of the powder. Around the positive pole there was formed a larger or smaller space free from the powder, which was chiefly collected at the negative pole. If the current had been allowed to pass for a time and the poles were then charged the strata disappeared and the chief part of the powder collected in the middle of the tube, probably owing to its static charges. The phenomenon agrees closely with Quet's stripes.

The author compares these distributions of the bronze-powder with the stratification of the gases, showing that both are influenced by the same circumstances, such as the quantity of electricity passing at each discharge, the width of the tube, the charge of its outer sides. As a repulsion of the particles situate near the electrodes could here be directly observed, the author considers that the stratification in Geissler's tubes depends on mechanical causes, as is assumed by De la Rive. He thinks, however, that not the rarefied but the condensed strata are luminous. He explains the stratification thus: as the electricity enters the tube, the sides and the gaseous molecules become saturated, and are repelled from the electrode and from the sides. The electrode moves the gas to the negative pole, and the sides of the tube impel it more feebly towards the axial line. From the reciprocal action of these forces result strata like the dust-figures seen in narrow streets after a high wind. As the bronze-powder is chiefly accumulated at the negative pole, the author concludes that the maximum density of the gas in Geissler's tubes is found at the negative pole. He seeks to explain the stratification in flames, the figures of Lichtenberg, &c., on the same principles. The author appends some remarks on Crookes' experiments, which he explains in accordance with his figures, and thus refutes the hypothesis of the fourth state of matter, but without submitting it to any thorough discussion.—*Beiblätter* (Wiedemann's), iv., No. 10.

Canadian Telegraphy.—Mr. J. A. Gisborn, superintendent of the Canadian Government telegraph lines, has returned to Ottawa, after having successfully laid a submarine cable connecting Anticosti, Magdalene Islands, Bird Rocks, and Cape Breton. It is stated that the Canadian Government is about to build a line from Sydney Mines to Cape North, touching at Lloyd's Cove and Englishtown; and that St. Paul's Island will be connected by cable. On St. Paul's Island a semaphore will be placed at the north-east end, so that all vessels passing up or down the gulf will be reported.

On the 11th inst., at the Physical Society, papers were read "On the rate of loss of light from phosphorescent surfaces," by Lieutenant Darwin, R.E., and "On the determination of chemical affinity in terms of electromotive force," by Dr. Alder Wright.

Adhesion of Metals occasioned by Electric Currents.—If two masses of metal, *e. g.*, two wires, or, better, two blades, the one fixed and the other attached to a lever, are brought together at an angle of

90°, and if a current is then passed through them they adhere together, according to the observations of A. Stroh. If the circuit is repeatedly closed there is heard a slight report at the point of adhesion, even if far remote from the closing point. The adhesion is strongest in the case of hard steel (=225 grm.) weaker in soft steel (100 grm.); then follow iron, platinum, lead, gold, zinc, silver, copper, decreasing as the conductive power increases. Microscopic examination shows that the edges are fused together at the point of contact, a strong heat being at first produced by the current. As the metals melt and larger surfaces are brought into contact the heat decreases. The report is due to the sudden expansion of the point of contact. Steel edges are rendered harder at the point of contact so that they scratch the file.—*Naturfascher*, xiii., No. 49.

A PROPORTIONAL part of the expense of lighting the Southwark and Blackfriars bridges by the electric light will be paid out of the Bridge House funds.

MR. EDISON is making arrangements for trying his incandescent lamps over 7½ miles of streets in Menlo Park and neighbourhood.

MESSRS. J. AND H. BERGE, of New York, have just completed a very large and finely-constructed double-plate Holtz electrical machine for E. N. Dickerson, Esq. This is probably the largest Holtz machine ever made, the revolving plates being forty-five inches in diameter, and other parts in proportion. By means of a continuous charging apparatus attached to the machine, the inductors may be readily charged without recourse to the catskin and rubber-plate. The machine, together with the charging apparatus, is mounted on a massive mahogany table, which is sufficiently large to support any apparatus used in experiments. By an ingenious arrangement of mechanism the crank which rotates the large plates is made to turn the charging apparatus. This machine is capable of yielding a 26-inch spark, accompanied by a report that is really startling. By way of contrast, this firm exhibit a diminutive Holtz machine having a 5-inch revolving plate, and yielding a 1-inch spark.—*Scientific American.*

THE following are the arrangements for the Friday evening meetings of the Royal Institution of Great Britain before Easter, 1881: January 21, Warren De La Rue, D.C.L., F.R.S., Sec. R. I., The Phenomena of the Electric Discharge with 14,400 Chloride of Silver Cells; January 28, Dr. Andrew Wilson, F.R.S.E., The Origin of Colonial Organisms; February 4, Dr. Arthur Schuster, F.R.S., The Teachings of Modern Spectroscopy; February 11, Robert S. Ball, LL.D., F.R.S., The Distances of the Stars; February 18, Sir John Lubbock, Bart., M.P., D.C.L., F.R.S., M.R.I., Fruits and Seeds; February 25, Dr. J. S. Burdon-Sanderson, LL.D., F.R.S., Excitability in Plants and Animals; March 4, Sir William Thomson, LL.D., F.R.S., Elasticity viewed as possibly a Mode of Motion; March 11, uncertain; March 18, Wm. H. Stone, M.D., Musical Pitch and its Determination; March 25, Alexander Buchan, M.A., F.R.S.E., Sec. Met. Soc. Scot., The Weather and Health of London; April 1, uncertain; April 8, Prof. Tyndall, D.C.L., F.R.S., M.R.I.

THE Watch Committee of the city of Liverpool invite tenders for lighting by means of the electric light several of the principal streets of that town.

ON THE SPACE PROTECTED BY A LIGHTNING-CONDUCTOR.—In the *Philosophical Magazine* for December is a paper bearing this title, by Mr. W. H. Preece. The author, after fully discussing the subject, says: "*Hence a lightning-rod protects a conic space whose height is the length of the rod, whose base is a circle having its radius equal to the height of the rod, and whose side is the quadrant of a circle whose radius is equal to the height of the rod.* I have carefully examined every record of accident that I could examine, and I have not yet found one case where damage was inflicted inside this cone when the building was properly protected. There are many cases where the pinnacles of the same turret of a church have been struck where one has had a rod attached to it; but it is clear that the other pinnacles were outside the cone, and, therefore, for protection, each pinnacle should have had its own rod. It is evident also that every prominent point of a building should have its rod, and that the higher the rod the greater is the space protected."

THE annual report of the president of the Western Union Telegraph Company for the year ending June 30th, 1880, furnishes many figures of interest to others than the stockholders of the company. The latter, however, appear to have no reason to complain, the net profits of the company for the year footing up over 5,000,000 dols., the capital stock of the company being about 41,000,000 dols. The net profits for the fourteen years from 1866 to 1880 exceed 45,000,000 dols. The telegraph business of the year is represented by 29,215,509 messages, 12,782,894,53 dols. receipts, 6,948,956,74 dols. expenses, and 5,833,937.79 dols. profits. The company has in operation 85,645 miles of line, 233,534 miles of wire, and occupies 9,077 offices. The new offices established and equipped during the year number 543. The number of messages sent was over 4,000,000 more than the year before. The increase in mileage of wire was 22,000 miles; the increase in miles of pole lines was 2,658. The ratio of expenses was 54 3-10 per cent. of the receipts, against expenses of 56 2-10 per cent. the previous year, and of 63 9-10 per cent. the year preceding that, and the cost per message reduced to the average of 22 3-10 cents, against 23 1-10 cents the previous year, 25 cents the year preceding that, and 29 8-10 cents the year ending in 1877. —*Scientific American.*

TRIALS have been lately made on the Rhine, in order that navigation may be carried on at night by means of the electric light.

THE TELEPHONE AND FIRES.—The Leeds Water Works and Fire Brigade Committees are about to adopt telephonic communication between the town-hall police station and the turncock's residence at the water works.

THE Committee of the Bristol Sanitary Authority have authorised the sum of £500 to be expended in experiments in the way of lighting the town by the electric light.

GAS has been readopted in the St. Lazare Station of the French Great Western Company, the gas company having declared that they would abolish entirely the special price charged on the Great Western Company if they declared in favour of gas.

THE Charing Cross Station of the South Eastern Railway is, it is said, to be lit by the Brush system, and the Cannon Street Station by the British Electric Light Company.

Correspondence.

FAST SPEED ON CABLES.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—With regard to the article in the TELEGRAPHIC JOURNAL, No. 187 (Nov. 15, 1880), on fast speed working on cables, I am glad to state that the German Government more than two months ago placed on their cables a system of duplex telegraphy with unrivalled success. The system is the invention of Geheimer Ober-Postrath Ludewig, one of the superintendents of the Postal Telegraph Department here. The arrangement can be used with equal success for aërial, underground (submarine) lines everywhere and for all distances, *where translators can conveniently be inserted.* [The italics are our own.—ED. T. J.] The carrying power is more than doubled by the employment of this duplex system.

Geh. R. Ludewig has authorised me to carry on all transactions with foreign parties, and I shall be glad, therefore, to furnish any particulars required.

Yours truly,
EMIL RATHENAU.

Berlin W., 5, Eichhorn-Str.,
Nov. 28th, 1880.

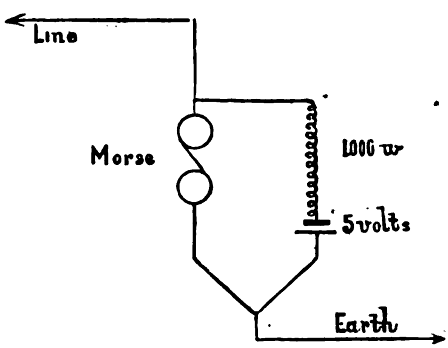
[Our correspondent has somewhat mistaken the drift of our article; the latter had reference to long ocean cables where translators *cannot* be inserted. Translators for increasing the speed of working on long lines have been extensively adopted in the British Postal Telegraph Department.—ED. TEL. JOUR.]

VYLE'S RELAY.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—To the description of Mr. Vyle's (or Mr. Brown's) adaptation of the Hughes' electro-magnet to relaying purposes, and to the subsequent information which has appeared in your columns, allow me to add that it is not only possible to magnetise the cores in the manner adopted by Mr. Bolton, but it is not necessary to use separate coils for that purpose.

An ordinary Morse instrument of about 120 ohms joined as below works well by double current on any ordinary line, with the usual working current of 8 or 10 milliwebers. A Morse or sounder wound to a higher resistance than that usually used would, with a permanent magnet, not only simplify and cheapen the apparatus, but would facilitate adjustment, relays being no longer necessary.



It would appear, indeed, that when the molecules of the core are twisted from their locked position of rest by a current, or by a permanent magnet, that they then accept motion with greater ease, and this seems to be the chief cause of the extreme sensitiveness of the Bell telephone and this instrument, while it is worthy of note that the armatures are induced through the attracting cores only.

Yours truly,
G. EDEN.

Govt. Telegraphs, Edinburgh.
December 7th, 1880.

CIRCULAR CARBON ELECTRODES.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I beg to forward you a copy of a letter I have sent to the editor of *La Lumière Electrique*. As it has reference indirectly to an article which appeared in your last issue, I shall feel obliged by your giving publicity thereto.

Yours truly,
CHARLES. F. HEINRICHS.

To the Editor of "La Lumière Electrique."

SIR,—I have noticed your remarks in the last issue of *La Lumière Electrique* on the subject of my ring-armature, and also your statement as to my "re-invention" of the Dubos regulator. As regards the latter, I beg to call your attention to the following facts, viz.:—That last summer when I had the pleasure of an interview with you, I proved to your satisfaction that the date of my British patent relating to my electric lamps with semi-circular carbon pencils is prior by quite two months to any of M. Dubos' patents relating to electric lamps with circular carbon pencils; that the "only similarity" of Dubos' regulator with mine is in the application of circular carbon pencils; that there has been no electric lamp with circular carbon pencils shown to the public prior to my patent and to my lamps. Thus the priority of the application of circular carbon pencils belongs to me.

It is therefore with surprise that I read your statement, but feel sure that your attention being called thereto, you will, in justice to me, make in your next issue due amends for what I trust is but the outcome of inadvertence.

Your obedient servant,
CHAS. F. HEINRICHS.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

AN ordinary general meeting of this Society was held on Wednesday, December 8, Mr. LATIMER-CLARK, past President, in the chair. The minutes of the last meeting having been read and confirmed, the list of new and proposed members was read.

A paper was then read by Mr. W. H. PREECE, President, on "The Photophone and the Conversion of Radiant Energy into Sound." Mr. Preece commenced his discourse by apologising for the incompleteness of the experiments, as there had been but a limited time to prepare them; he also announced that Professor Bell had come over specially from Paris to be present at the lecture and to take part in it himself. Mr. Preece stated that he was honoured in having been able first to introduce to the notice of the Society the telephone, the phonograph, and the microphone. He then proceeded with the general subject of his paper. Sound is a physiological action producing a sensation on the ear; it cannot exist independent of

the brain, it being purely undulations in the molecules of matter. To produce the effect known as sound three things are necessary, viz., a "transmitter," a "medium," and a "receiver." Whenever air is set in vibration sound is produced. If two tuning-forks be set close together, and one be sounded, the vibrations set up in the air will cause the second fork to vibrate and render a sound audible. In the case of Wheatstone's telephonic concert the sounds from musical instruments were conveyed along wooden rods, and rendered audible to the senses by a sounding board placed on the ends of the rods, thus enabling the vibrations to be imparted to the air. With reference to the subject to which the title of his paper referred, radiant energy existed in every physical force, as, for instance, in light, where the luminous relations were radiated from the source. In the spectrum we have radiant energy existing in its component form. If an electric circuit containing a telephone be continually interrupted and made a sound due to a series of clicks is produced, and if these clicks follow one another rapidly a musical note is produced; to produce articulation, pitch, loudness, and quality are necessary. How can radiant energy vary the strength of a current so as to vary the current in a telephone and produce articulation? Mr. Willoughby Smith discovered that radiant energy in the form of light affected the electrical resistance of selenium. Lieut. Sale, Professor Adams, Dr. Siemens, Lord Ross, and others proved that the effect was due to light and not to heat. Dr. Siemens also showed that the resistance varied according to the intensity of the light, and proposed to construct a photometer on the principle, but the experiment failed owing to the variable nature of the selenium. The question whether the effect of light was to vary the resistance or to generate an electro-motive force had been tried by Professor Adams, and it was proved that a slight photo-electromotive force was produced, though there could be no question but that the resistance was also affected. Mr. Crookes tried an experiment with his radiometer by coating the vanes on one side with selenium and the other side with chromic oxide. It was found that a white light from a wax candle caused the selenium surfaces to retreat, whilst the yellow light from a sperm candle caused the chromic surfaces to retreat. Mr. Sabine in 1878 (*see* Tel. Jour., Aug. 1, Aug. 15, Sep. 1, 1878) made some experiments with two plates of selenium immersed in a cell filled with water. He found that when one of the plates was exposed to the light a current was generated in one direction, whilst if the other plate was the one exposed the current became reversed. Professor Minchin had attacked the subject from a photographic point of view, viz., he studied the actinic effect on chemicals (*see* Tel. Jour., Sep. 15, Oct. 1, Oct. 15, 1880). He tried two plates of tinfoil immersed in hard water, and found that a current was produced by exposing one plate to the action of light; the direction of the current, however, became reversed after a time. With reference to the cause of the action of light on selenium, Mr. Preece did not venture to express a theory. Professor Bell had expressed an opinion that light could be made to produce sound, and Mr. Willoughby Smith had actually succeeded in doing this to a slight extent. The great difficulty in making the experiment had been in producing a piece of selenium of a sufficiently low resistance. This had been done by Professor Bell in the peculiar form of cell he had devised. Mr. Shelford Bidwell had followed up Professor Bell, and had produced an equally effective cell (*see* Telegraphic Journal, Dec. 1st). (Mr. Bidwell's experiments were repeated with an Edison receiver, and an audible sound was produced by a rapidly intermitted beam of electric light falling on the selenium cell.) Mr. Preece, in conclusion, quoted some poetic extracts, which appeared to have foreshadowed the possibility of hearing light.

Professor Bell, who was received with acclamation, then proceeded to describe the experiments which he, with the assistance of Mr. Summer-Tainter, had made. Up to the present time selenium was the only substance which had been proved to be actively sensitive to light as regards its electrical resistance. It seemed probable that other non-metallic substances, such as tellurium, sulphur, and phosphorus would be similarly affected. Indeed, sulphur, when heated to a certain point and cooled slowly, conducted; and the experiment might be tried with it, though it had not yet been done. From the fact that very rapid makes and breaks could be heard in an electro-magnet, Professor Bell was led to conclude that all matter might be affected. At first the experiments with light on matter failed, but when experimenting with the selenium photophone it was found that a sheet of thin ebonite interposed in the path of the beam of light did not extinguish the sound, and subsequently, on placing the sheet of ebonite *on the* ear, and allowing the beam of light to be intermitted upon it, a sound was heard. Other substances were tried with like effect. It then occured to Professor Bell that if the light acted on the *surface* of the substance that the greater sound would be produced on that side, the intermittent light was therefore allowed to fall inside, and on the sides of a tube to which an ear-piece was connected, and a good sound was heard. It was further found that if the beam of light were thrown directly into the ear a sound was produced by the intermittence of the beam. The experiments were chiefly made by inclosing the substances acted upon in a test-tube, to which a flexible pipe and ear-piece were connected (*see* Telegraphic Journal, Nov. 1, 1880). The electric light was found to produce better effects than sunlight.

In the discussion which followed the discourses,

Professor Adams stated that he had found that selenium changed its resistance greatly by time, a specimen which gave originally a resistance of 7,600,000 ohms in 1876 fell as low as 745 ohms in 1877. He stated that the electromotive force set up *in the selenium* was but very small, and that the change that took place was chiefly in resistance.

Professor Tyndall said that there could be no doubt but that other substances than selenium were affected by the action of light. He could corroborate the results of the experiments made by Professor Bell, as he had personally witnessed them. He thought, however, that the effects were possibly due to heat, and not to light. As a test experiment he had tried a test-tube filled with vapour of bisulphide of carbon, and also a tube filled with the vapour of sulphuric ether; in the second case sound was produced, but none in the first case; and inasmuch as the bisulphide allowed the heat rays to pass through freely, whereas the ether did not, the result pointed strongly to the conclusion that heat was the cause of the sound effects, and not light.

A vote of thanks having been proposed and passed, the meeting then adjourned.

THE PHYSICAL SOCIETY.—Nov. 27, 1880.

Prof. W. G. Adams in the chair.

New member—H. C. Jones, F.C.S.

Prof. Graham Bell exhibited his photophone, and explained the apparatus employed by Mr. Sumner-Tainter and himself for transmitting sounds by a beam of light. The form in use consists of

a metal plate or mirror vibrated by the sound and reflecting a beam of light to a distance, where it is focussed on a selenium cell in circuit with a telephone and battery. The light undulates in sympathy with the vibrations of sound, and alters the resistance of the selenium in accordance with the vibrations, thereby reproducing the sound in the telephone. The electric light used was too unsteady to give articulate speech; but by means of a rotating disc, perforated round its rim with holes, the light could be occulted in such a manner as to give an audible note in the telephone. Different varieties of receivers were described, some of which have not yet been tried. One of these consisted in varying the rotation of the plane of polarisation of the polarised beam. A plan for transmitting the beam consists in making the vibrating plate vary the supply of gas to a jet or manometric flame. The farthest distance speech has been heard by photophone is 800 feet; but theoretically it should operate better the greater the distance between the mirror and selenium. On interposing a sheet of hard rubber in the ray the invisible rays passing through it conveyed the sounds in a lower degree, and sounds can be heard by replacing the selenium receiver by discs of different materials, such as hard rubber, metal, &c., and simply listening at them. All substances appear to possess the power of becoming sonorous under the influence of varying light. Hard rubber, antimony, zinc give the best effects; paper, glass, carbon, the worst. Even tobacco smoke in a glass test-tube held in the beam emitted a note, as also did crystals of sulphate of copper. When hard rubber was simply made into the form of an ear-tube and held in the beam the audible effect was also produced, and, in fact, when the beam was focussed in the ear itself, without any other appliance whatever, a distinct sound could be perceived.

Prof. ADAMS thanked Prof. Bell in the name of the Society, and called on Mr. SHELFORD BIDWELL, who exhibited a lecture photophone, in which the reflector for receiving the light was discarded and the beam focussed on the selenium by a lens. The two lenses used cost only twenty-five shillings, and the beam was sent fourteen feet. The selenium cell was made by spreading melted selenium over sheets of mica, and then crystallising it by heat. For mica Prof. BELL recommended microscopic glass. The resistance of the cell was 14,000 ohms in the dark and 6,500 in the light. Speech was distinctly transmitted by this apparatus.

Mr. J. SPILLER thought that since selenium probably alloyed with brass and the baser metals, it would be better to use gold and silver for the cells; but Prof. BELL said that he preferred brass, since (perhaps for the reason that Mr. Spiller gave) it yielded the best results.

Dr. J. H. GLADSTONE read a paper on the specific refraction and dispersion of isomeric bodies, an extension of his paper of last June. He concluded that the dispersion of a body containing carbon of the higher refraction is very much greater than that of a body containing carbon of the normal refraction, 5; and that isomeric bodies which coincide in specific refraction coincide also in specific dispersion.

New Patents—1880.

4933. "Improvements in electric lamps and in the materials employed in their construction." J. W. SWAN. Dated November 27.

4940. "Improvements in signals or communications between passengers and companys' servants when travelling by railway, and in other modes of signalling." J. UPTON. Dated November 27.

4952. "Improvements in furnaces and in the metallurgy of copper and in the method of varying the electrical conductibility of copper." A. M. CLARK. (Communicated by J. Garnier.) Dated November 27.

4961. "Mechanical contrivances for electro-magnetic clocks and apparatus." J. MAYR. Dated November 29.

4981. "Improvements in and relating to telephonic apparatus." W. R. LAKE. (Communicated by C. A. Randall.) Dated November 30.

4988. "Electric lamps." K. W. HEDGES. Dated November 30.

5004. "Improvements in measuring and recording electric currents and in the apparatus employed therein." J. W. SWAN. Dated December 1.

5007. "Mariners' and azimuth compasses." J. READMAN. Dated December 1.

5008. "Electro-magnetic induction machines." H. WILDE. Dated December 1.

5014. "Improvements in and connected with electric lamps." J. W. SWAN. Dated December 2.

5022. "Improved means for indicating the heating of bearings in steam-engines and other machinery." H. W. WIMSHURST. Dated December 2.

5033. "Improvements in electric lamps." J. H. JOHNSON. (Communicated by A. de Méritens.) Dated December 3.

5051. "Timepieces worked by electricity." W. P. THOMPSON. (Communicated by A. Lemoine.) Dated December 4.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

1580. "Dynamo-electric machines." EDWIN POWLEY ALEXANDER. (A communication from abroad by Karl Zipernowsky, of Buda-Pest, in the Austrian Em-

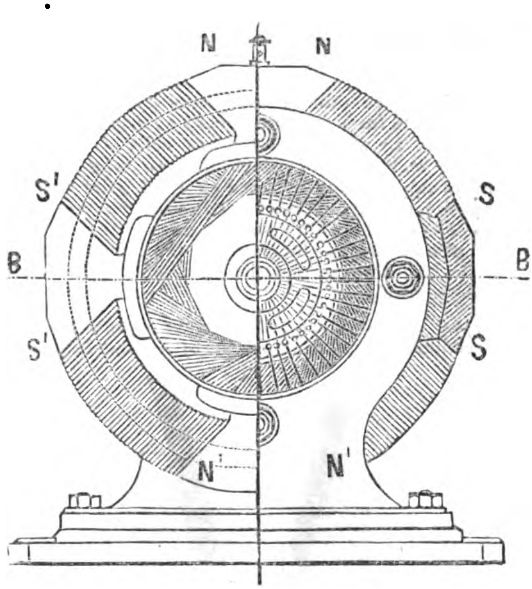


FIG. 1.

pire.) Dated April 17. 6d. Relates to a construction of dynamo-electric machines, whereby they are rendered capable of producing electrical currents of great ten-

sion, suitable for maintaining a number of lights in one circuit, or for maintaining lights or producing mechanical power at considerable distances. Fig. 1 of the drawings represents a half-end elevation and half-transverse section of the said improved dynamo-electric machine; fig. 2 is a longitudinal vertical section of the same. The apparatus consists of a cylindrical armature, wound longitudinally with insulated wire, and carried in bearings in the framing, B B, and rotated between the ring-shaped magnets, N N, S S, N[1] N[1], S[1] S[1]. By means of the driving pulley, C, there are provided polar extensions projecting inwards, and so arranged that those of opposite polarity follow each other. By the rotation of the armature the currents produced in the same will change their direction 4 or 6 or 8 times during one revolution, according to the number of polar extensions. Of the currents so produced, one or more are employed for exciting the electro-magnets, in order to be utilised as dynamo-electric currents, while others form separate circuits as magneto-electric currents. By winding on the wire coils of the armature in rectangles, of which the two long sides are always approaching or receding from polar fields of opposite polarity, as before described, the portions of the coils situated at the smaller sides of the rectangle will also be effective by reason of the inductive action of the iron core, so that the whole of the wire coil is rendered available.

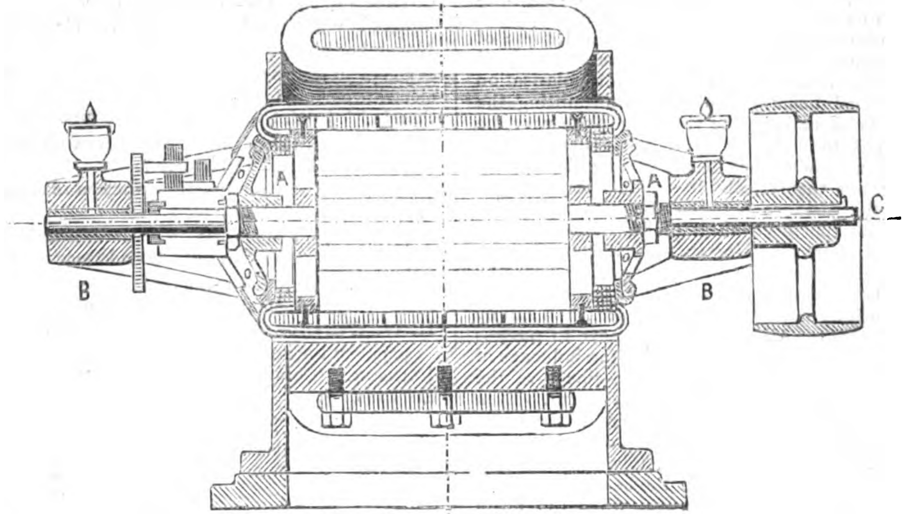
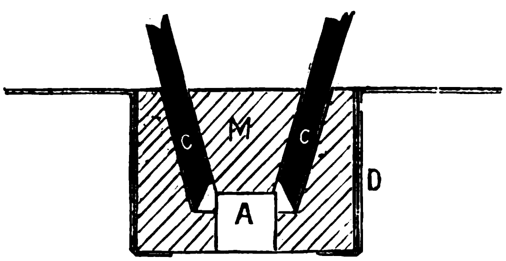


FIG. 2.

1704. "Electric lamps." HERBERT JOHN HADDAN. (A communication from abroad by Antoine Bureau, of Belgium.) Dated April 26. 6d. Relates to a new type of electric lamps, and consists in guiding the voltaic arc in a block of refractory material, and in the method of rendering the light constant and of the desired tint. For this purpose the contiguous extremities of the carbons are embedded in the refractory material and the latter cut out, as shown by the figure, so as to form a vault directed towards the side which is to be illuminated. At the top of this vault are two orifices, which communicate with the points of the carbons, thereby forcing the arc to take the prescribed way.



The following are the final quotations of telegraphs for the 13th inst.:—Anglo-American Limited, 63½-64; Ditto, Preferred, 92½-93½; Ditto, Deferred, 34½-35; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9⅞-10⅛; Cuba, Limited, 8¾-9¼; Cuba, Limited, 10 per cent. Preference, 16¼-16¾; Direct Spanish, Limited, 2⅞-3⅛; Direct Spanish, 10 per cent. Preference, 12¼-12¾; Direct United States Cable, Limited, 1877, 11⅞-12⅛; Scrip of Debentures, 102-104; Eastern, Limited, 9¾-10; Eastern 6 per cent. Preference, 12¾-13; Eastern, 6 per cent. Debentures, repayable October, 1883, 102-106; Eastern 5 per cent. Debentures, repayable August, 1887, 102-105; Eastern, 5 per cent., repayable Aug., 1899, 104-107; Eastern Extension, Australasian and China, Limited, 10-10¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 105-107; Ditto, registered, repayable 1900, 105-107; Ditto, 5 per cent. Debenture, 1890, 101-103; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 103-105; Ditto, ditto, to bearer, 102-104; German Union Telegraph and Trust, 10-10⅛; Globe Telegraph and Trust, Limited, 6¾-7; Globe, 6 per cent. Preference, 12⅛-12⅜; Great Northern, 11-11¼; Indo-European, Limited, 25-26; London Platino-Brazilian, Limited, 5¾-6¼; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 10¾-11¼; Submarine, 260-270; Submarine Scrip, 2½-2¾; West Coast of America, Limited, 3-3¼; West India and Panama, Limited, 2⅛-2⅜; Ditto, 6 per cent. First Preference, 6¾-7¼; Ditto, ditto, Second Preference, 6¼-6¾; Western and Brazilian, Limited, 9-9¼; Ditto, 6 per cent. Debentures "A," 106-110; Ditto, ditto, ditto, "B," 98-101; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 34¾-35¼; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3¾-4; India Rubber Company, 17½-18; Ditto, 6 per cent. Debenture, 106-108.

End,